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CONTENTS

Wage Incentives. *By Julian Chase* 15
Drive On to Attain Volume Car Production. *By Leonard Westrate* 17
Engine Performance of Substitute Motor Fuels. *By Donald B. Brooks* 18
Machining Bronze Counterweights for B-29 Crankshafts. *By Joseph Geschelin* 22
Standardized Aircraft Wiring System. *By Reginald H. W. Cox and W. E. Hill* 25
New Crossley Diesel 26
Control System of the Lockheed Constellation. *By Clarence L. "Kelly" Johnson* 28
The French Gnome-Rhone Mechanically Operated Propeller. *By John D. Waugh* 34
New Production Equipment 38
Special Hub is Crucial Unit in Army Duck Tire Inflation 39
Discrepancies in Primary Balancing of Radial Engines. *By G. L. Williams and A. B. Miller* 40
New Products for Aircraft 42
New Products 44
Details of the Willys Peacetime Jeep 46
News of the Industry 48
Ryan Nomogram 72
Advertisers' Index 206

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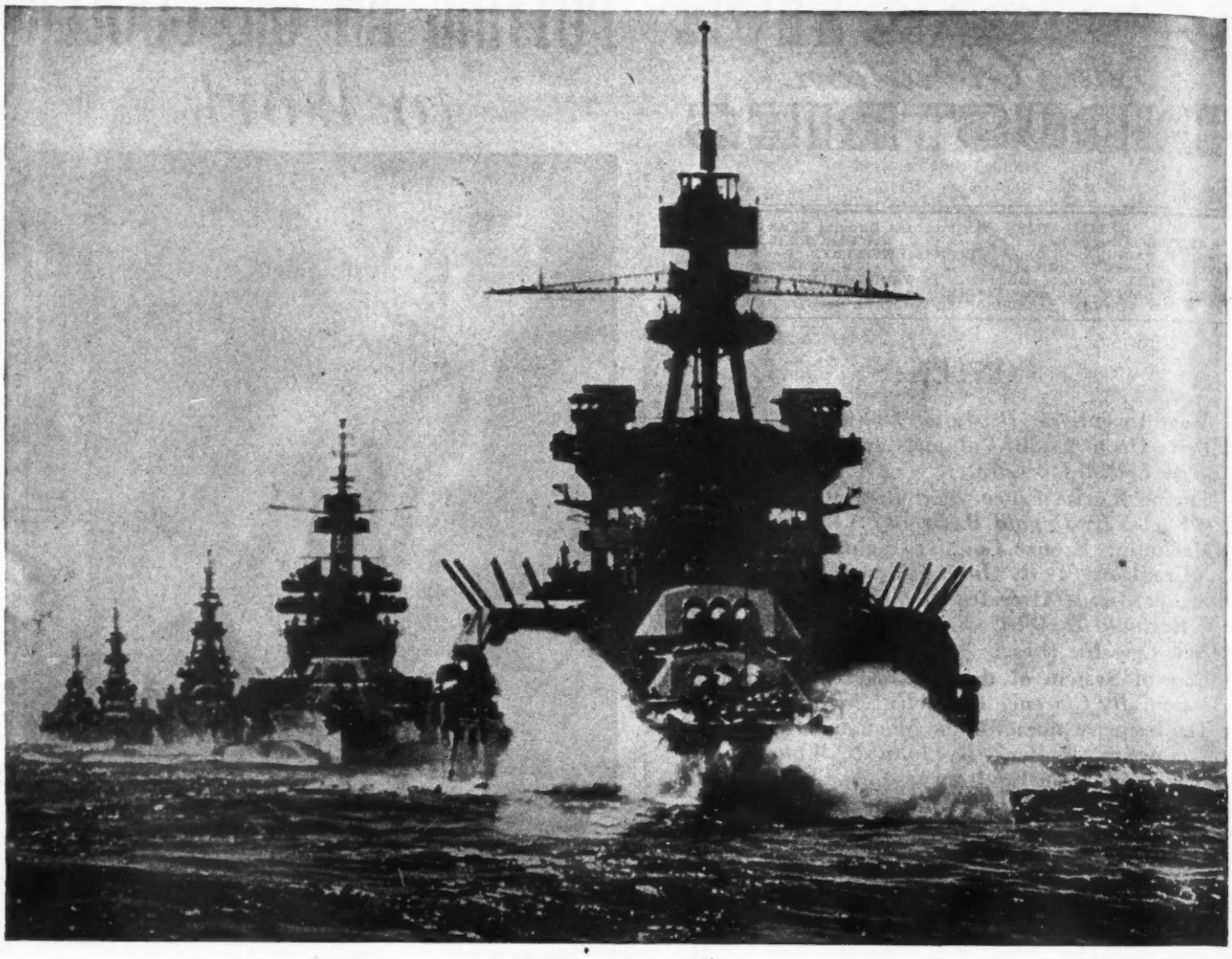

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Wage Incentives

By Julian Chase

Not long ago a wage incentive conference was sponsored by the National Industrial Engineering Society. Among the speakers were James F. Lincoln, president of the Lincoln Electric Co., and Edward T. Cheyfitz, National Member of the C.I.O. Reconversion Committee. In what they said, each supplemented the other. What they both said may, in part at least, be summarized in the following manner:

What we want and need in this country is not so many jobs—60 million or some other number—but a standard of living. To get that standard of living, we must have maximum production and adequate profits for business. To get the greatest possible production and, resultantly, the highest possible standard of living, we must have wage incentives in an atmosphere or condition of freedom.

It is difficult to understand how there can be the slightest disagreement with any part of such a statement of our requirements. It all seems basic, fundamental and something that should be obvious. And yet, strangely enough, in too many quarters it is by no means apparent. Some take exception to one part, others to another. Some discount the whole thing as last-gasp propaganda of a decadent capitalism. Even at this late stage of our economic development, it is something which, surprisingly, must be sold in whole or in part to many of our citizens and, more surprisingly, to many of our lawmakers.

During the past two years or so, our legislative politicians have repeatedly cried "Jobs, jobs, jobs—60 million jobs." They have declaimed dramatically about the right of everyone to a job. They have had much less to say, directly at least, about a higher standard of living with fewer onerous jobs and more livable leisure for a greater part of our people.

As James F. Lincoln pointed out at the conference referred to, there are 100 million jobs and even more available in this country today. Years ago, he said, most of our people lived on farms, little farms and big ones. They got along without unemployment and they never talked about jobs. They all had jobs, everyone willing and able to work, but they did not have our standard of living. There are today and will be tomorrow, he added, more jobs than people to fill them.

But the job itself is not the critical thing. It is what a job produces. What and how much a man turns out in useful products and services constitutes his real contribution to his own and the national welfare. It is not so much the fact that he works as the volume or value which results from his productive effort that counts in raising the standard of living not only for himself but for everybody.

During the days of war production, wage incentives have come into greater prominence through wider use than heretofore. There is nothing new about them.

(*Turn to page* 106, *please*)

CINCINNATI APPLICATION ENGINEERS

catch the little details you might overlook

The broaching job illustrated is one of those run of the mine parts which could be tooled up in several ways. But a slight difference in the technique of adjusting four of the broaching inserts gives the setup a distinct advantage in economical production.

Four radii and two sides of the part are broached on a CINCINNATI No. 3-48 Single Ram Hydro-Broach. The four broaching tools for the radii are jackscrew adjusted rather than the conventional taper gib adjustment. This arrangement (for light cuts only) greatly facilitates adjustment to correct sizing dimensions after the tools have been ground, and eliminates shimming of excessively worn tools.

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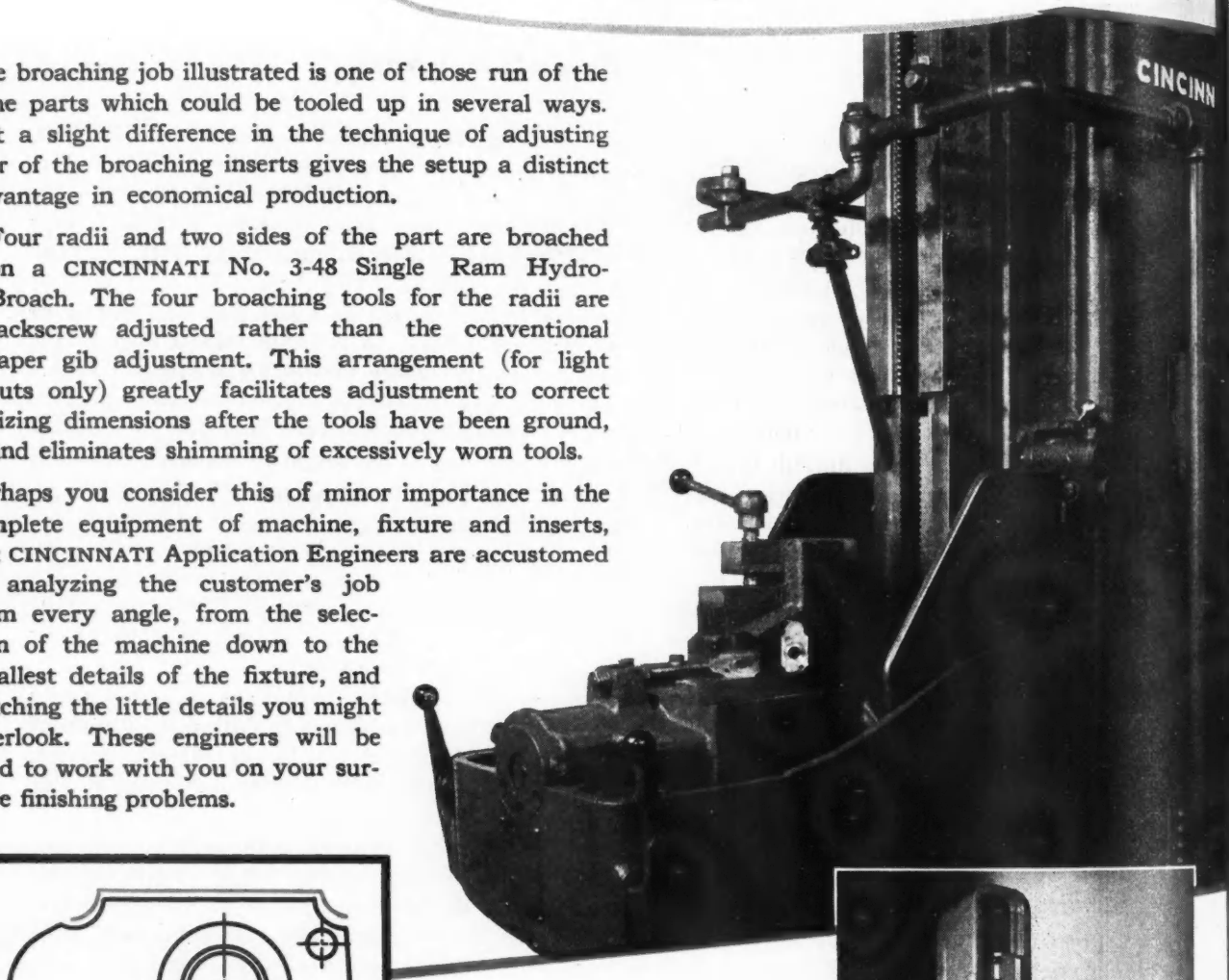
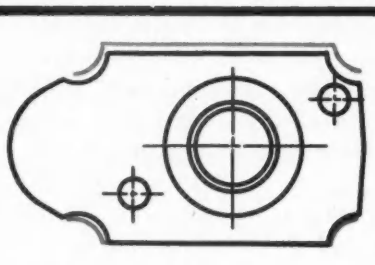
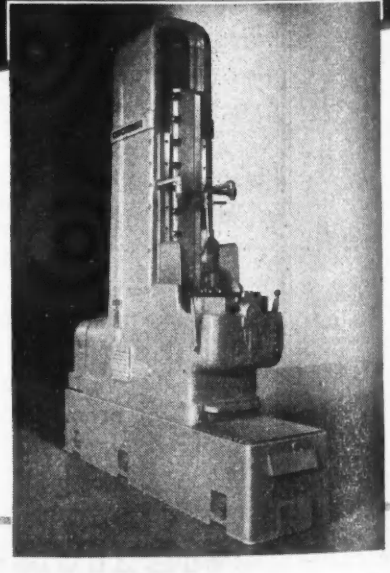




Name of part: Pump Body
Material: Steel Forging
Operation: Broach 2 sides and four radii (indicated by heavy lines)
Machine: CINCINNATI No. 3-48 Single Ram Hydro-Broach
Production: 193 parts per hour

CINCINNATI No. 3-48 Single Ram Vertical Hydro-Broach Machine. A brief description of this machine is given in Sweet's Catalog File for Mechanical Industries. Complete specifications may be obtained by writing for Catalog No. M-1389.



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Drive On to Attain Volume Car Production

By Leonard Westrate

ALTHOUGH the sudden end of the war with its attendant deluge of contract cancellations left a wake of confusion in the automobile industry, there is a growing hope that volume production of cars will be achieved by the end of the year, or early in 1946. For one thing, work on partial reconversion was fairly well along on V-J day and facilities were nearly ready to go in most companies for resumption of production in October and November. Whether or not the impetus of peace will bring the start of assembly lines any closer is a moot question, but there is growing optimism that if the machinery of Government works swiftly enough in translating war contract terminations into available materials, principally sheet and strip steel, cars will be coming off the assembly lines somewhat sooner than had been expected.

Ford, of course, has been in production on a limited basis since July 3 and is in the best shape to hit top production first, probably within four to five months. The Rouge plant and the Edgewater, Louisville, Dallas, and Buffalo branch plants now are in operation and others will be ready to go soon. Company spokesmen say that at the peak Ford will be building close to 8000 cars a day.

General Motors divisions are little inclined to discuss probable starting dates, but from what can be gleaned they stand something like this: Chevrolet probably will start sometime in September at one of its branch plants, possibly Atlanta, and a little later at others. Production at Flint is not expected to get underway until the new plant which the company is building there is completed. Pontiac and Oldsmobile may get started in September. Buick will in late September or early October. Cadillac is expected to be a little later.

Chrysler also is an unknown quantity. It is generally believed, however, that production will be coming along in late October or November. First shipment of bodies are scheduled for mid-September on Plymouth, so it is unlikely that any production would start before mid-October.

Studebaker will go about the first week in October with all initial production concentrated on the Champion line. The company has been building the Champion engine for use in military vehicles so that line is still intact and can be turned to immediate civilian use. Resumption of higher-priced models will come along a little later when facilities can be cleared.

Packard plans call for resumption of car manufacture in October. Although facilities were tied up with contracts for marine and aircraft engines, enough space had been cleared to carry on the limited production allowed under War Production Board quotas.

Hudson is scheduled to begin turning out a few cars the first of September. Nash expects to start production by the last week in September and to hit its prewar level by the end of the year and its full postwar stride in May.

So far as reconversion progress is concerned, it looks good up to the two-million car a year rate, but not too favorable beyond that, according to George Romney, general manager of the Automobile Manufacturers Association. Preparatory work allowed by the Government after the fall of Germany was not sufficient to take care of the sudden impact of peace, he stated, but all possible measures will be taken to make up for lost time. He predicted that unemployment in the automobile industry would be prevalent for several weeks, but that the upward swing would start about October.

Added to the natural incentive of getting plants back to civilian operation as soon as possible in order to reap from a huge backlog market is the pressure of unemployment, which is expected to reach a total of from 250,000 to 300,000 persons in Detroit. How soon the industry can re-employ a large number of those out of work will depend on several factors, namely—swiftness of plant clearance, availability of materials, date of delivery of machines and equipment needed for

(*Turn to page* 58, *please*)

Engine Performance of S

IT IS probably no more than a slight exaggeration to say that the number of gallons of alcohol motor fuel consumed in this country does not greatly exceed the number of pints of ink consumed in arguing the relative merits of alcohol and gasoline as motor fuels. One of the most competent investigations of this subject was carried out in 1912 by R. M. Strong and Lauson Stone, and was published as Bulletin 43 of the Bureau of Mines. Although the engines used in this work would now be rated as museum pieces, the results are in excellent agreement with the latest data. The following is a quotation from Bulletin 43:

"A gasoline engine working at the degree of compression ordinarily used for gasoline mixtures will, in general, require 50 per cent more denatured alcohol than gasoline per brake horsepower-hour."

In the third of a century which has elapsed since these investigators made their report, many conflicting claims regarding the relative efficacy of alcohol and gasoline have been put forth. Institutions and foundations have given their blessing to test results purporting to show that more power, twice the mileage, better acceleration, and longer engine life resulted from the use of alcohol. Other organizations have claimed that use of alcohol resulted in a disastrous increase in cylinder wear, that it increased starting difficulties, or that it caused contamination of the lubricating oil.

Early in 1942, it became difficult to supply some friendly countries with gasoline for the transport of

By Donald B. Brooks

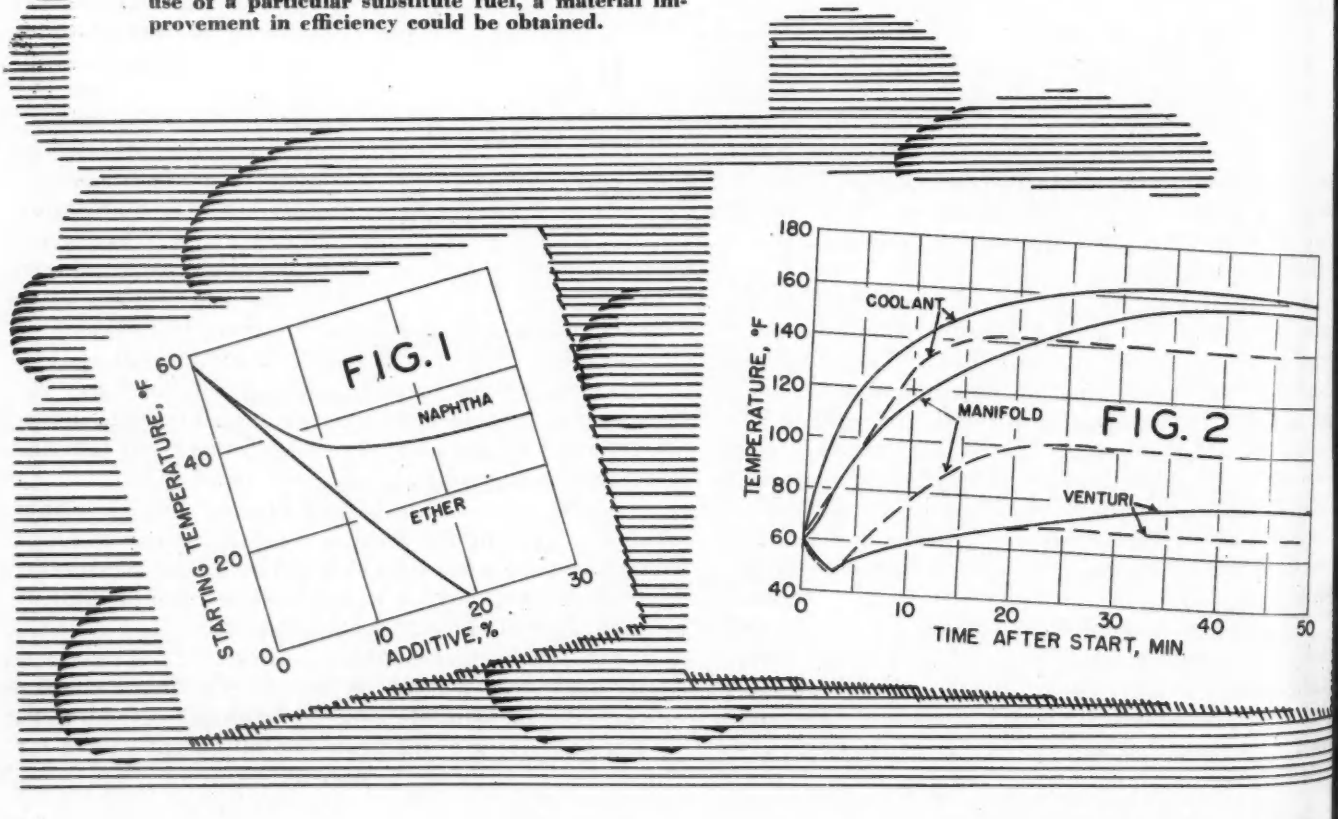
Chief, Automotive Section,
National Bureau of Standards

THE results of an extensive investigation of substitute motor fuels are summarized in this article. The work covered starting, vapor lock, distribution, knock rating, power, economy, cylinder wear, engine deposits and other aspects of fuel performance. The tests showed that substitute liquid fuels can be used satisfactorily, give power about equal to gasoline but poorer economy, and do not increase wear. Charcoal gas used in a conventional engine gives but little more than half of normal power. By designing an engine for the use of a particular substitute fuel, a material improvement in efficiency could be obtained.

Fig. 1.—Starting Temperatures for Blends of Ethyl Alcohol with Diethyl Ether and with Blending Naphtha.

Fig. 2.—Coolant, Intake Manifold, and Carburetor Venturi Temperatures During Warm-Up.

The solid lines are for a run on gasoline, and the broken lines for one on ethyl alcohol.



Substitute Motor Fuels

critically needed materials to seaports, because of the loss of oil tankers by enemy action. A possible alternative was the local production of substitute fuels from vegetable matter. In studying this alternative, the Foreign Economic Administration asked the National Bureau of Standards to investigate fully the engine performance of substitute motor fuels, of which alcohol was the most promising. The resulting investigation included charcoal, shale oil, naphtha, vegetable products and certain fuel gases. On the liquid fuels, the work covered studies of the volatility of the fuels and blends, rate of evaporation loss, effect on pump diaphragms, starting, warm-up, vapor lock, manifold distribution, knock rating, power, economy, spark advance, oil consumption and dilution, engine deposits, cylinder wear, and exhaust composition. It is the purpose of this article to review briefly the results of this work, the technical details of which are currently being published in the Journal of Research of the National Bureau of Standards.

Tests on Liquid Fuels

To be a satisfactory substitute fuel, a compound or blend must start, warm up, operate without knock in present engines, must give reasonable power and economy, and it must not vapor lock, cause oil contamination, or undue wear or corrosion of the engine or fuel system. The liquid fuels under study were

Table 1

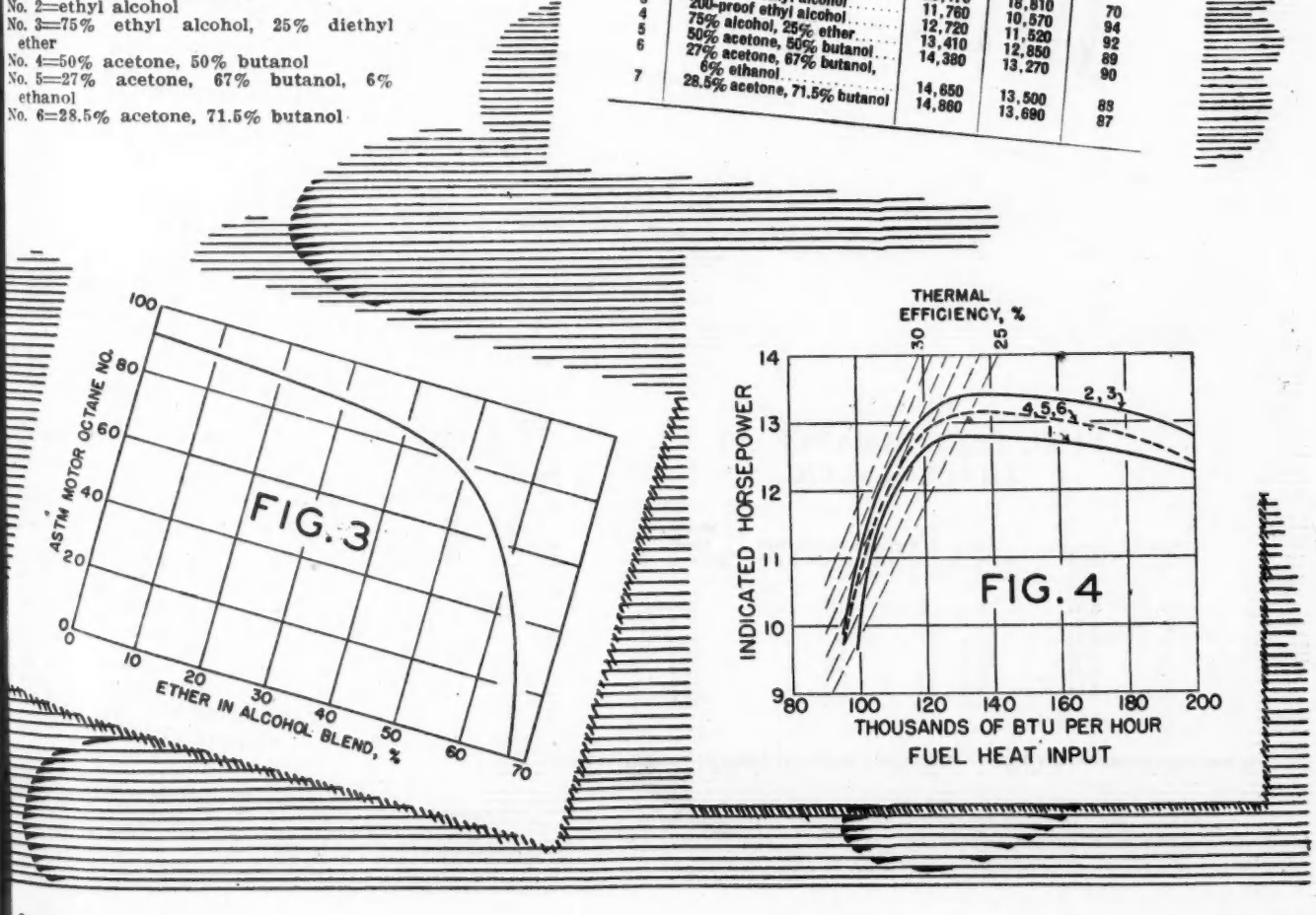
COMPOSITION AND PROPERTIES OF TEST FUELS

Fuel No.	Composition	Heat of Combustion Btu/lb		ASTM Motor Octane Number
		Higher	Lower	
1	Reference gasoline	20,170	18,810	70
2	190-proof ethyl alcohol	11,760	10,570	94
3	200-proof ethyl alcohol	12,720	11,520	92
4	75% alcohol, 25% ether	13,410	12,850	89
5	50% acetone, 50% butanol	14,380	13,270	90
6	27% acetone, 67% butanol, 6% ethanol	14,650	13,500	88
7	28.5% acetone, 71.5% butanol	14,860	13,690	87

Fig. 3. — ASTM Motor Octane Number of Blends of Diethyl Ether in Ethyl Alcohol.

Fig. 4.—Power Developed by Gasoline and Substitute Fuels at a Compression Ratio of 5.11.

No. 1=70-octane number gasoline
No. 2=ethyl alcohol
No. 3=75% ethyl alcohol, 25% diethyl ether
No. 4=50% acetone, 50% butanol
No. 5=27% acetone, 67% butanol, 6% ethanol
No. 6=28.5% acetone, 71.5% butanol



the products derived from vegetable matter by fermentation: ethyl alcohol, acetone, and butanol; and blends of these with each other, with diethyl ether (readily derived from alcohol), or with petroleum products. As the work progressed, the emphasis shifted continually toward alcohol blends.

Starting tests were made on a late-model V-8 engine, mounted in a cold chamber. The test procedure followed Designation F-6-543 of the Coordinating Fuel Research Committee. Ethyl alcohol, either absolute (200-proof) or technical (190-proof) was found to start at 58 F. With gasoline, there is a considerable range of temperature in which you cross your fingers and hope the engine will start, but with alcohol, this range is not more than one or two degrees. Above 60 F, starting usually occurred within a second; below 58 F, cranking for several minutes was unavailing. Results of a series of car tests confirmed the laboratory tests: starting at 60 F was easy, but no start was obtained at temperatures below 58 F.

By the addition of diethyl ether to the alcohol, starting at much lower temperatures can be had. Acetone, gasoline or even blending naphtha have similar effects. The relation of starting temperature to concentration of additive is shown in Fig. 1 for diethyl ether and for blending

Fig. 5. — Manifold Distribution of Gasoline, Ethyl Alcohol, and Butanol.
The height of the bar graphs shows the relative amount of fuel reaching each cylinder.

Fig. 6.—Power Developed by Gasoline and Substitute Fuels when Operating at Compression Ratio for Trace Knock with Each Fuel.

No.	Fuel	Comp. Ratio
1	70-octane number gasoline	5.11
2	Ethyl alcohol	9.91
3	75% ethyl alcohol, 25% diethyl ether	8.60
4	50% acetone, 50% butanol	8.18
5	27% acetone, 67% butanol, 6% ethanol	7.81
6	28.5% acetone, 71.5% butanol	7.43

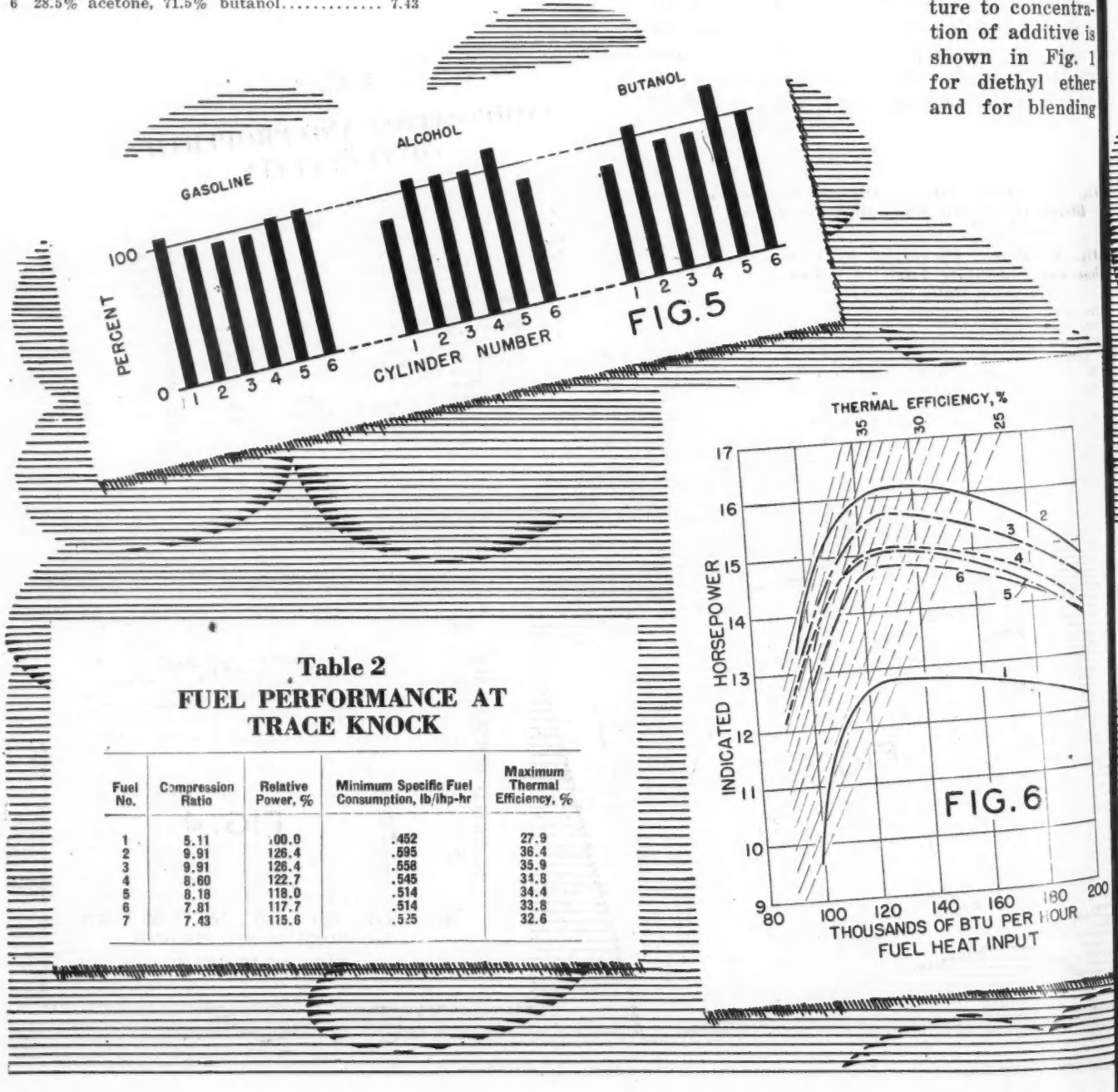


Table 2
FUEL PERFORMANCE AT TRACE KNOCK

Fuel No.	Compression Ratio	Relative Power, %	Minimum Specific Fuel Consumption, lb/ihp-hr	Maximum Thermal Efficiency, %
1	5.11	100.0	.452	27.9
2	9.91	126.4	.595	36.4
3	9.91	126.4	.558	35.9
4	8.60	122.7	.545	34.8
5	8.18	118.0	.514	34.4
6	7.81	117.7	.514	33.8
7	7.43	115.6	.525	32.6

naphtha. Thus the addition of 20 per cent of naphtha to alcohol lowers the starting temperature to 32 F, while 20 per cent of ether lowers it to 0 F.

The warming-up process is not only slower with alcohol, but it does not proceed to the same level as with gasoline. Data obtained in the cold-chamber tests are shown in Fig. 2. When alcohol was the fuel, the intake manifold in particular ran cooler than with gasoline, in these tests by about 40 deg F. This results from the greater amount of heat required to vaporize the alcohol. The latent heat of vaporization of alcohol is a little more than three times that of gasoline *per pound*, but roughly 1½ times as many pounds of alcohol are required for similar engine operation. Hence the heat absorbed in the complete vaporization of the charge would be five times as great for alcohol as for gasoline.

Tests showed that all of the substitute fuels and blends were satisfactory as far as knock rating was concerned. Ratings of blends of alcohol with ether, of especial interest because of the value of the latter as a starting agent, are shown in Fig. 3. Blends containing less than 50 per cent of ether are seen to rate above motor gasoline. In a car, however, with a blend containing 25 per cent ether, two or three sharp knocks will be heard when the accelerator is depressed suddenly. Under these conditions the highly-volatile ether, which vaporizes almost completely in the manifold, reaches the cylinders more quickly than the unvaporized alcohol, and thus the cylinder receives a mixture containing much more than the original 25 per cent of ether.

With the fuels listed in Table 1, power and economy tests were run on a single-cylinder test engine, and on stock automobile engines of three makes. The

(*Turn to page* 60, *please*)

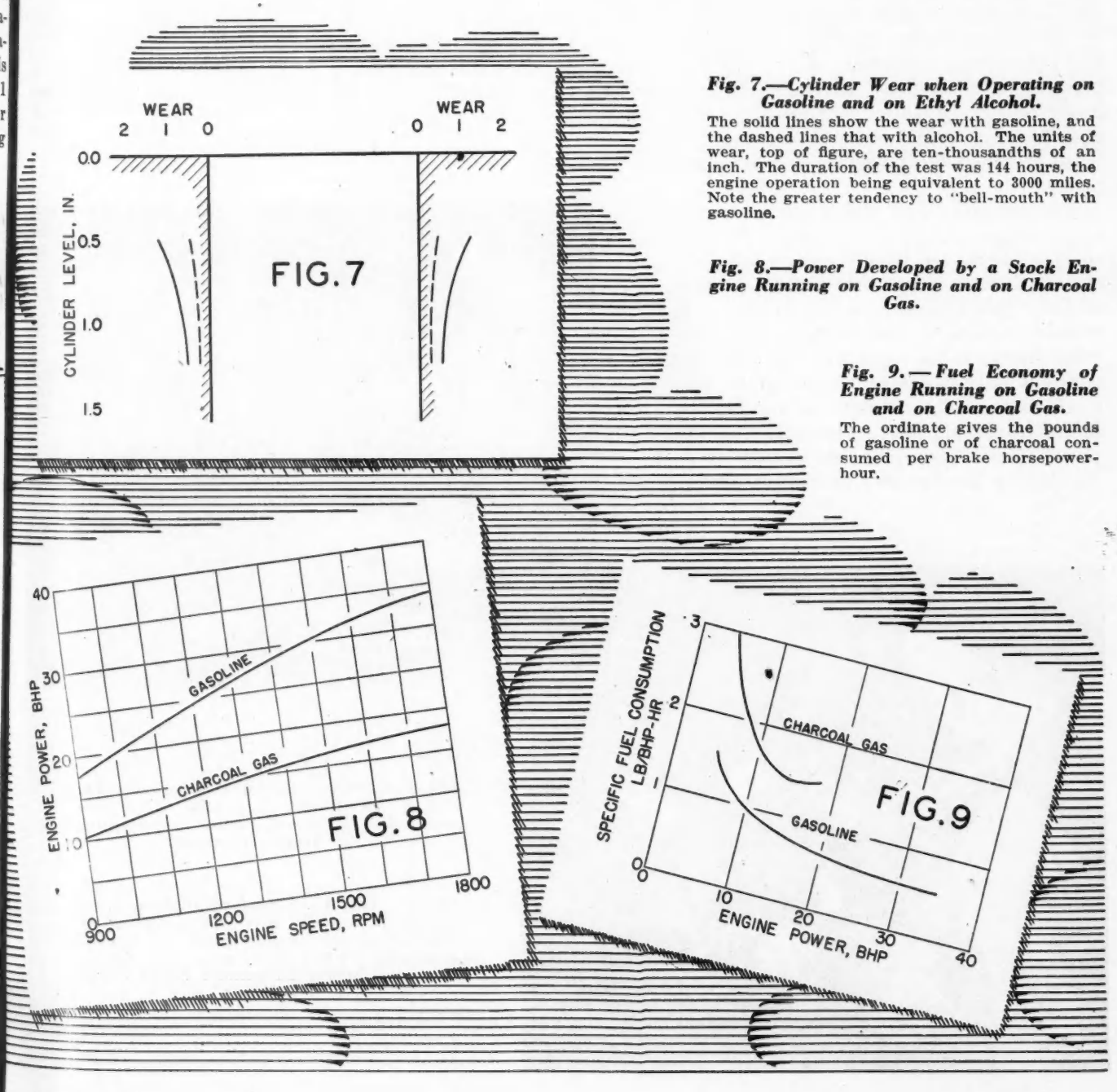


Fig. 7.—Cylinder Wear when Operating on Gasoline and on Ethyl Alcohol.
The solid lines show the wear with gasoline, and the dashed lines that with alcohol. The units of wear, top of figure, are ten-thousandths of an inch. The duration of the test was 144 hours, the engine operation being equivalent to 3000 miles. Note the greater tendency to "bell-mouth" with gasoline.

Fig. 8.—Power Developed by a Stock Engine Running on Gasoline and on Charcoal Gas.

Fig. 9.—Fuel Economy of Engine Running on Gasoline and on Charcoal Gas.
The ordinate gives the pounds of gasoline or of charcoal consumed per brake horsepower-hour.

AN OUTSTANDING example of versatility was demonstrated recently by The Ohio Crankshaft Co. by placing in production the crankshaft for the B-29 engine while continuing the manufacture of a smaller two-throw crankshaft for Wright. Under pressure of time and limited facilities, the machine shop operations for the B-29 crankshaft were interspersed with those of the existing line and tooled on machines without interrupting schedules. That is why an observer will find batches of large crankshafts moving on the conveyor along with smaller crankshafts. To facilitate identification, each of the machines set up for B-29 crankshafts bears a large red symbol. "Red" machine tools spell out the course of operations threading in and out of the regular line.

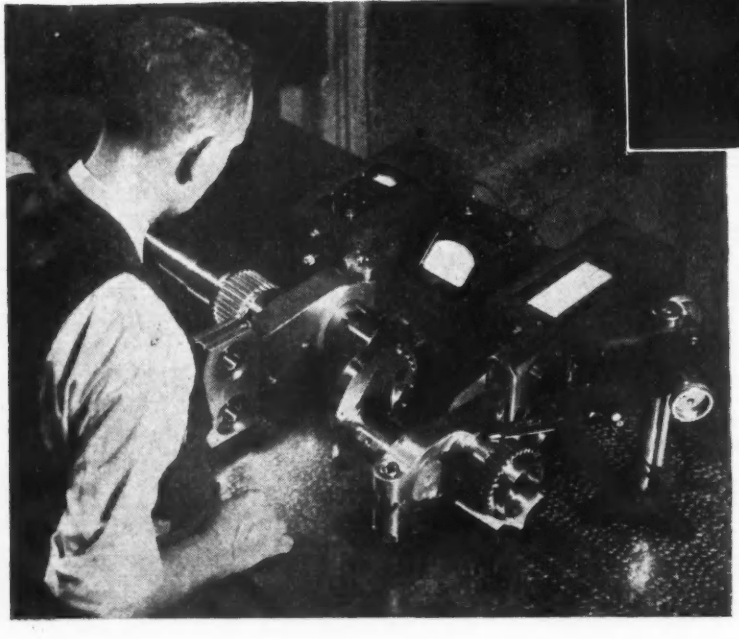
On casual observation the crankshaft appears to have only five parts—the front, center, and rear sections, and the two counterweights. Actually the assembly is composed of some 50 pieces, ranging from the major parts to small fastenings. This multiplicity of parts complicates the task of assembly, disassembly, and re-assembly of the crankshaft as it proceeds from the initial machining stages to the final inspection. As a matter of interest, it may be noted that the rough weight of the B-29 crankshaft is about 386 pounds; finished weight is 192 pounds.

Although the B-29 crankshaft is larger and heavier than the crankshaft for the smaller 14-cylinder Wright engine, both are quite similar in appearance and in general design. This accounts for the similarity in process, making it feasible to handle both crankshafts on the same machine line. In fact, the only major difference in the two crankshafts is the counterweights. On the larger crankshaft the counterweight is composed of two forged bronze sections, thus simplifying the assembly by eliminating the two bronze plates used in the standard steel counterweight and still used on the smaller crankshaft.

The shift to bronze forgings made it imperative to set up an entirely new and self-contained machine line for counterweights. There were two reasons for this decision. In the first place, it was necessary to have a segregation of dis-similar chips. But more important was the need for entirely different methods of work-holding since the magnetic chucks used on the steel counterweight section could not be applied for non-magnetic parts. The need for positive clamping devices brought about a complete change in tooling and fixture design as well as modified procedures.

The B-29 crankshaft is a thing of beauty and precision. But the term precision is relative and the nature of tolerances and surface finishes must be appraised in terms of size. Remember that this crankshaft weighs about 192 pounds finished, is

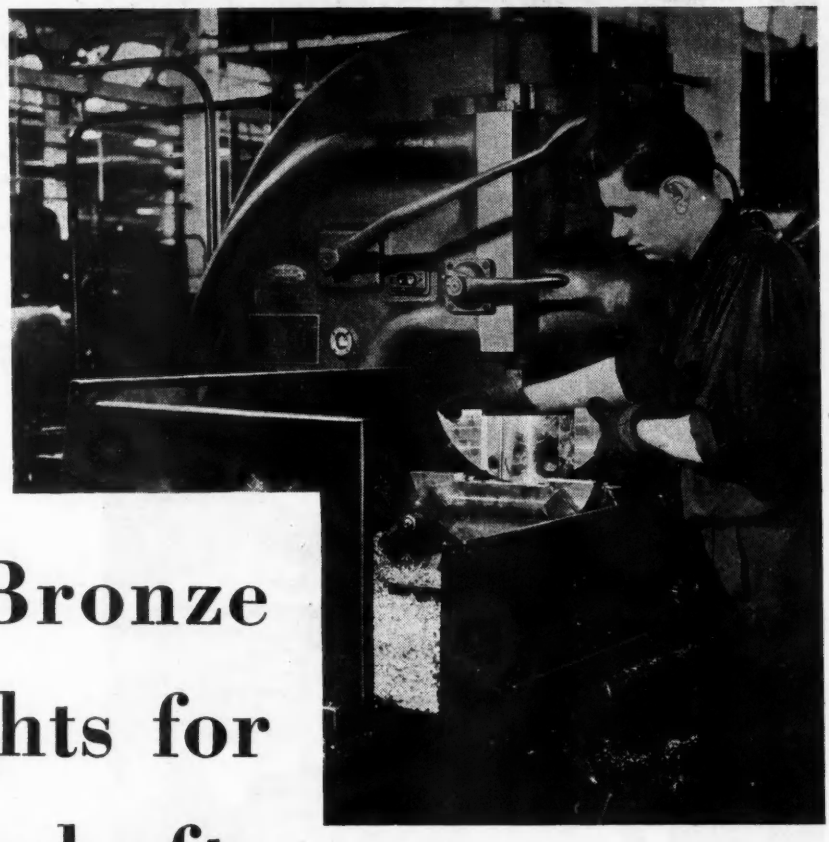
This is the 109th in the series of monthly production features



(Above)—Final inspection procedure. The P & W Electrolimit gage, used as an "electric mike" is shown gaging the propeller end bearing diameter.

(Left)—The Brush Surface Analyzer is the master instrument used for sampling inspection of the surface finish of finished crankshafts. This view shows the inspection of a 2600-B 14-cylinder radial engine crankshaft.

Initial operations on the counterweight sections are handled on a battery of Kearney & Trecker vertical milling machines. This view shows the milling of the top step, taking two sections at a time in the fixture.



Machining Bronze Counterweights for B-29 Crankshafts

By Joseph Geschelin

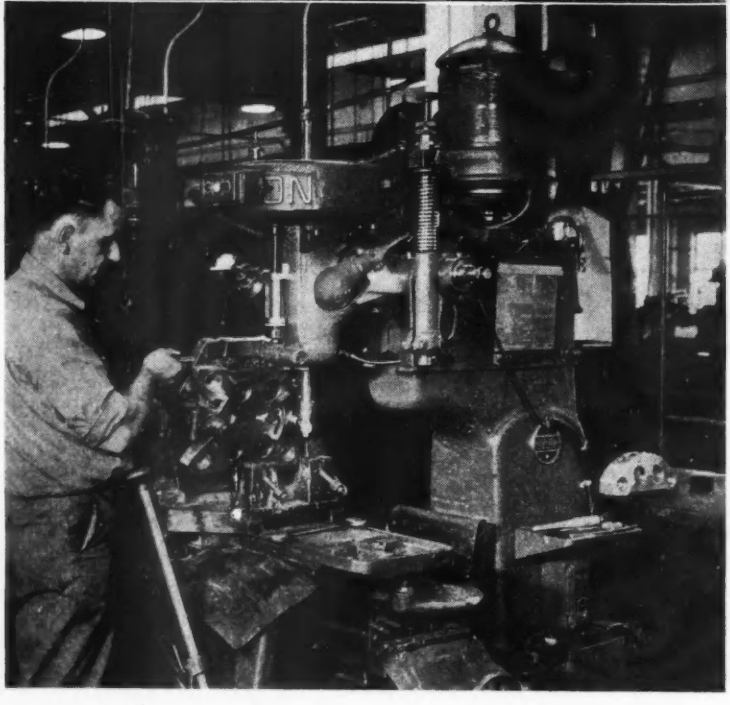
(Left) — Double-end Heald Bore-matic is used for the precision-boring of holes in assembled counterweights. The cutters are tipped with cemented-carbide.

about 39 inches in length, and has relatively large bearing diameters when compared with ordinary automotive crankshafts. The overall length is held to plus or minus 0.003 in. At the present time the axial concentricity of the assembly with respect to the main bearings is held to 0.002 in. indicator reading at the extreme ends. Dynamic balance of the assembly is held to 2 ounce-inches, maximum, which is said to be an exceptional specification for a part of this size and form.

Made much like a fine precision instrument, the dimensional tolerances and specifications for surface finish are quite unusual. About 160 dimensions are held to a tolerance of plus or minus 0.001 in. Many of these dimensions are checked with Pratt & Whitney "electric mikes," a special form of the familiar Electrolimit gage. Some examples of fine tolerances are listed below:

Pin bearings	plus or minus 0.0005 in.
Main bearings (front and rear).	plus or minus 0.0003 in.
Center main bearing	plus or minus 0.00025 in.
Diameter of external splines	plus or minus 0.0005 in. (over wires)
Bores for studs in counterweights .	plus or minus 0.00035 in. (precision bored)

The parts are finished all over with surface finish specified in terms of micro-inches (rms) as standardized by the Brush Surface Analyzer. At one time purely a research instrument, the Brush machine is now a production inspection tool used in the machine shop as a master check against micro finish by the inspection department; also for sampling checks by WAC and AAF inspectors. Maximum surface finish



(Top)—Foster Fastermatic lathe setup for roughing and finish-turning the angular portion and radius of counterweight sections. The fixture accommodates two sections at a time. Metal removal is done with cemented-carbide-tipped tools.

(Center) — One of a group of Cincinnati horizontal and Duplex milling machines in the counterweight department. Four counterweight assemblies are straddle-milled in one setting on this horizontal mill.

(Bottom)—One of a battery of the familiar Gorton profilers for cutting the two keyways in the sections of the counterweight. The fixture holds two sections at a time.

specifications in micro-inches for some parts are listed below:

Crankpins, 4; thrust faces, 6; propeller shaft bearing, 8; main bearings, 10; large precision bores in counterweights, 20,

The familiar Scandia large production stud driving machine is used for the assembly of the main sections of the crankshaft. The fastenings are aircraft quality "stretch" bolts. Each bolt is gaged for overall length before assembly, then gaged while taken up with the Scandia machine until the specified elongation of 0.009 to 0.010 in. is reached. The criterion of elongation offers the most positive means of assuring uniformity of clamping.

The Ohio Crankshaft procedure for manufacturing Wright crankshafts was described in some detail in AUTOMOTIVE AND AVIATION INDUSTRIES March 1, 1942. Since the same methods are employed for the machining of the B-29 crankshaft, no further comment is necessary in this article. However, the bronze counterweight line is entirely new and deserves brief description at this point. It may be noted that practically all of the operations on milling machines, lathes, and precision boring machines are done with cemented-carbide-tipped tools. In particular, the plain face milling operation on the Kearney & Trecker mill is done at exceptionally high speed and piles up an enormous heap of chips.

Owing to the differences in the front and rear counterweight assemblies, there are corresponding differences in machine setup and tooling for the sections and sub-assemblies. To facilitate ready identification of machine operations, each of the machines bears a large numbered tag painted with an identifying color. Only the initial rough-milling operations are common to the various sections and bear the same color—Red.

To give the reader some impression of the steps involved in the manufacture of the counterweights we are reproducing here the routing for one section and one assembly;

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Standardized Aircraft Wiring System

By Reginald H. W. Cox and W. E. Hill

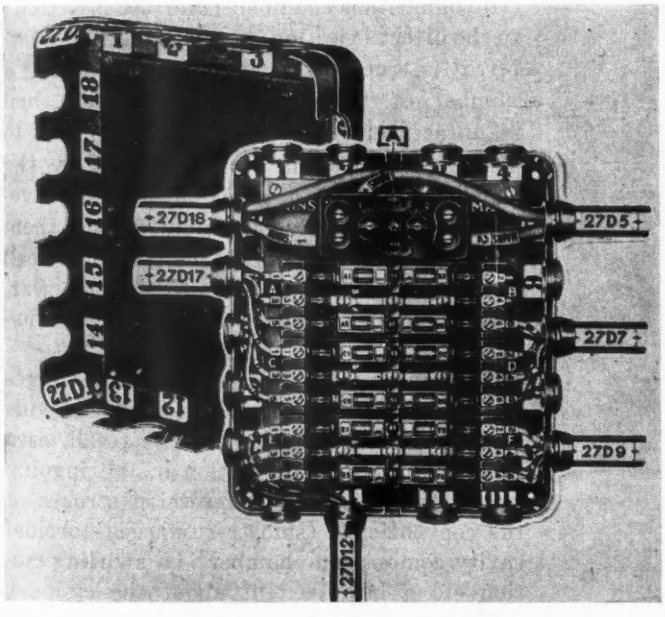


Fig. 1—Distribution Board showing fuseways and inner frame of junction box.

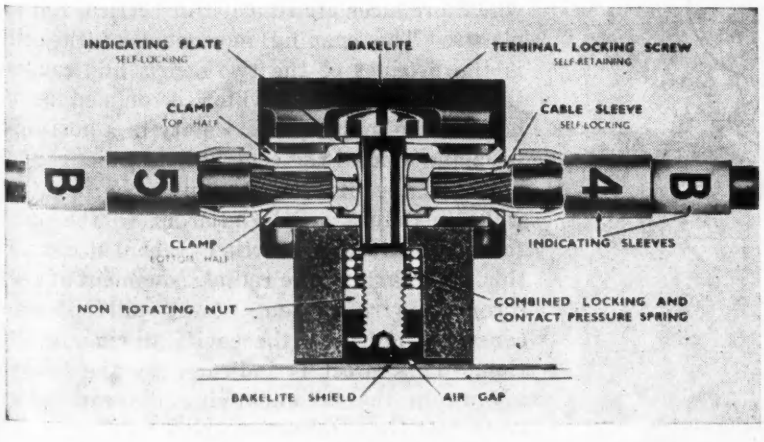


Fig. 2—Typical, straight-through, single-tier terminal.

A NEW system of wiring has been standardized for British civil and military aircraft, a development which reflects credit upon the Society of British Aircraft Constructors and the Ministry of Aircraft Production. Some credit for this major advance may also be taken by the British electrical industry, for it was inspired by the system for wiring aircraft developed by J. A. Crabtree & Co., Ltd., in 1941.

The Crabtree system marks a complete departure from aero-wiring methods. It is, in principle, the well-tried, point-to-point method so familiar to electrical installation engineers, but adapted to aviation service requirements and designed to conform with modern methods of aircraft construction.

Interconnection between all points can be made with either single-conductor or multi-core cables fitted directly to the airframe structure. Any form of distribution can be achieved by fixing the main distribution and junction boxes at appropriate points throughout the aircraft. The components of the installation are individually accessible so that modifications and replacements can be made with the minimum of disturbance to the installation. Standard Air Ministry cables, employed throughout, are cut to the required lengths and fitted with identification sleeves.

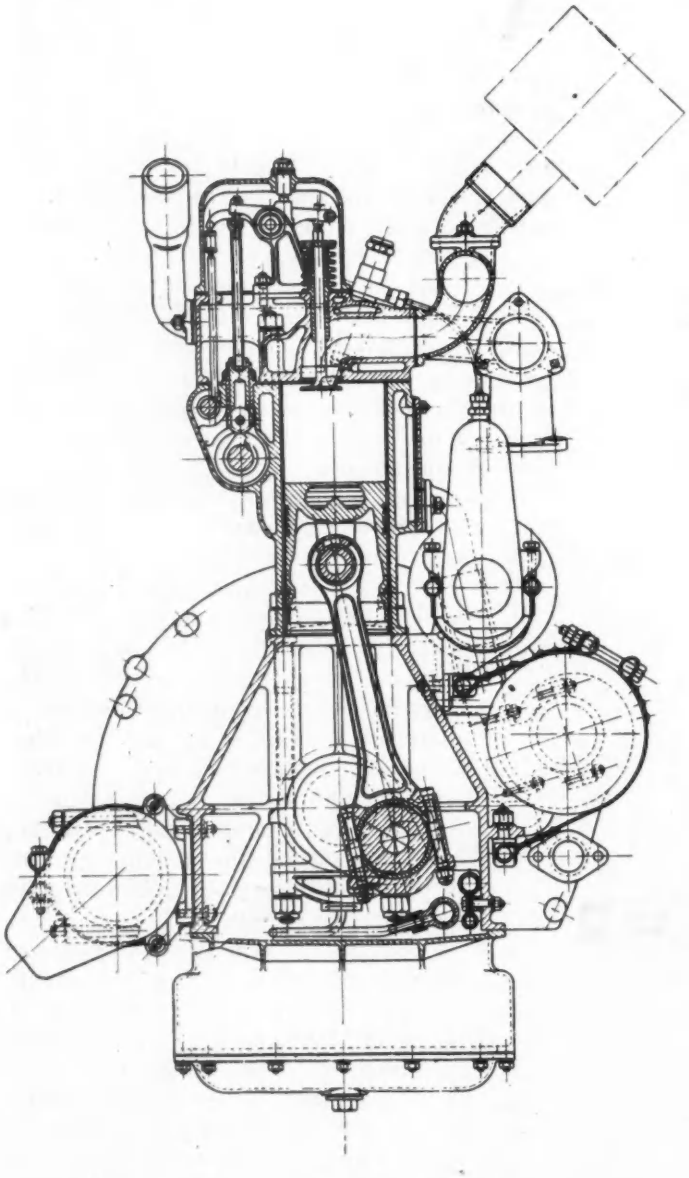
Conduit is extruded from a polyvinyl chloride compound and is in four standard sizes of the following diameters: ¼ in., ⅜ in., ½ in., and ⅝ in. To enable it to be directly-connected without tools to the distribution and junction boxes, each length, after being cut to size, is fitted with grooved-end bushes. The

(*Turn to page* 116, *please*)

New Crossley D

CROSSLEY MOTORS, Manchester, England, which has specialized in Diesel-engined buses since 1931 and was the first British firm to standardize a Diesel-engined bus as a complete unit, has now in production a new six-cylinder Diesel engine with a piston cavity type combustion chamber of novel design. The special feature is that the surfaces of the outer walls of the cavity, but not the central boss therein, are ridged or corrrugated, with proved benefit in respect of fuel economy, smoothness of running and other factors of operating efficiency. The advantages of this feature of design, and the general reliability of the engine, have been made manifest during a three-year test in the Manchester Municipal bus service under normal operating conditions.

Although in most other respects this new engine follows more or less orthodox automobile Diesel practice, it has a number of distinctive details. It represents, too, a trend that has been evident in British practice during the past eight or ten years, i.e. a reversion from the separate air-cell combustion chamber (indirect injection) to the direct injection system. While the latter, it is true, has never lost favor among a number of truck and bus operators and manufacturers, for they have continued to use direct injection as represented by the Gardner and Perkins stock engines, some vehicle manufacturers—Crossley among them—designed and produced their own air-cell type engine for some time prior to the war, after originally using the direct injection type.



Transverse section of new Crossley Diesel engine.

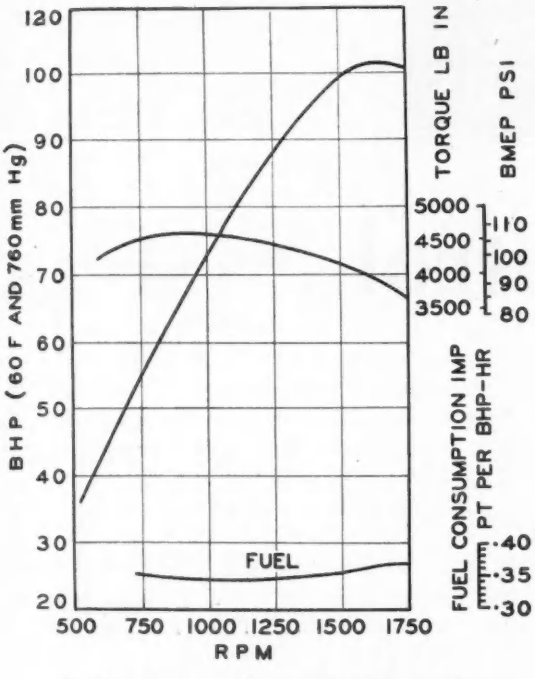
Explaining why, in their view, the ridges or corrugations of the piston cavity provide marked benefit, Crossley Motors recall, as a preliminary, that the motion of the ingoing air on the inlet and compression strokes of the conventional (smooth-surfaced) toroidal cavity combustion chamber is a swirling motion—to a large extent about the cylinder axis—set up by reason of a masked inlet valve or by the shape of the inlet port, or by both. During and at the end of the compression stroke, the air thus in motion is projected into the piston cavity, the shape of which produces air rotation in vertical radial planes. The ensuing movement of the air is the product of the two swirls and causes the toroidal motion, which is defined as a helical flow in the piston cavity in a horizontal plane around the central boss.

But in the Crossley design the corrugated walls introduce swirls adjacent to the surfaces, resulting in further turbulence, and this, by retarding the radial component of the toroidal swirl, prevents "over-spill" of unconsumed air from the cavity during injection. This effect is indicated by the heavy arrows in the accompanying diagrammatic section of the combustion space.

Located in the cylinder head, the four-

Diesel

has Corrugated Toroidal Cavity Combustion Chamber

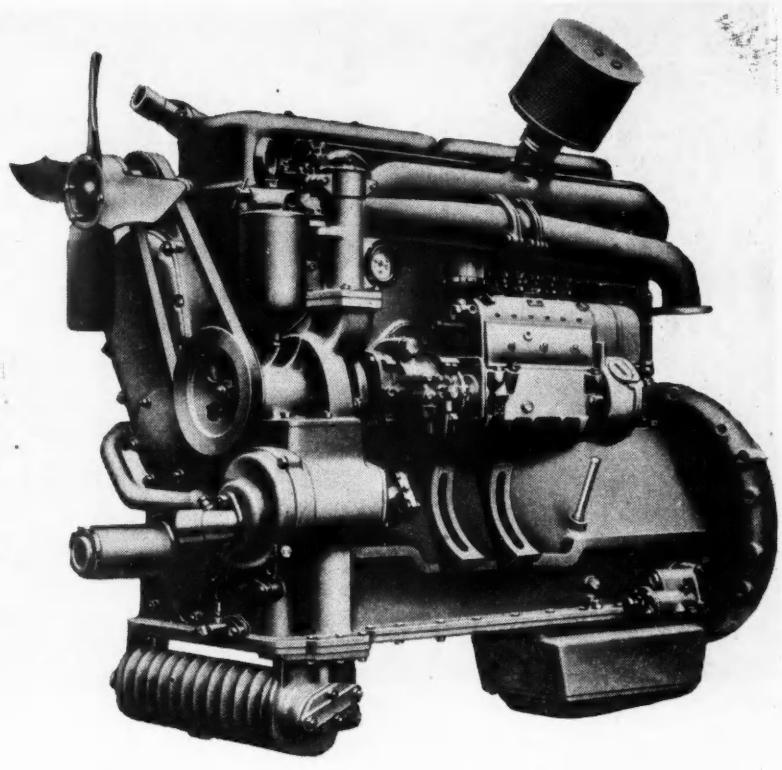


Performance and consumption curves of the new Crossley engine.

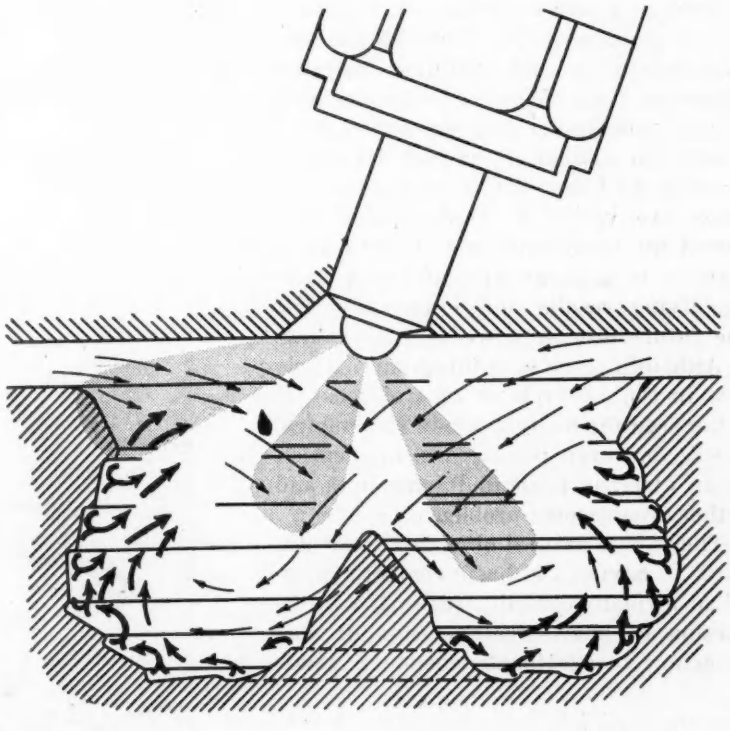
spray nozzle has its holes so arranged that the sprays are directed radially and at a shallow angle into the cavity, cutting across the toroidal swirl. The valves are slightly to the right of the cylinder axis; masked inlets are used, to give the ingoing air a pronounced peripheral swirl. Mechanical considerations necessitate the injectors being inclined from the vertical, but the nozzle is in the center of the cylinder head and the spray holes are so drilled as to be symmetrical within the piston cavity.

Unusually low injection pressure is possible with this type of combustion space. The standard setting is 1470-1760 psi, which is much below the pressure used in the majority of direct injection engines. Injection pressure can be reduced 880 psi without affecting engine performance. Even the

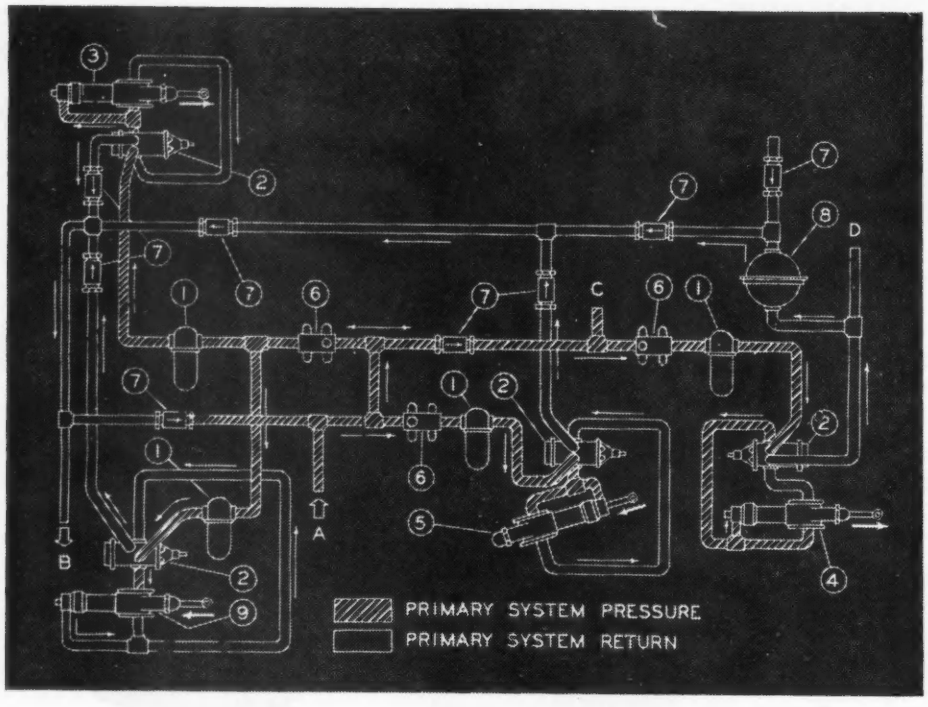
(*Turn to page* 80, *please*)



New British Crossley Diesel engine for buses. All auxiliaries except the starting motor are on this side. The exterior fins of the transverse oil filter are now omitted, the maximum oil temp having been found to be low enough without them.



Diagrammatic section of the piston-cavity type combustion chamber. The heavy arrows show the effect of the corrugated walls upon air motion during and at the end of the compression stroke.



Schematic diagram of hydraulic surface control booster system.

Note: Arrows indicate following surface movements: Right aileron — Up elevator — Right rudder

1—Filter (hydraulic boosters)
2—Booster control valve
3—Aileron booster cylinder (RH)
4—Elevator booster cylinder
5—Rudder booster cylinder
6—Shut off valve
7—Check valve
8—Tank (auxiliary booster system)
9—Aileron booster cylinder (LH)

A—Primary pressure
B—Auxiliary pressure
C—Primary return
D—Auxiliary return

Control System

LOCKHEED has been interested in the possibilities of applying hydraulic control surface boosters to large planes for some time. As early as 1939 an extensive long-range research program was undertaken on the general subject of hydraulically-boosted control systems and by the time the initial studies were made on the Constellation we were able to layout the airplane in such a way as to obtain the basic advantages of such a system from the outset of the project.

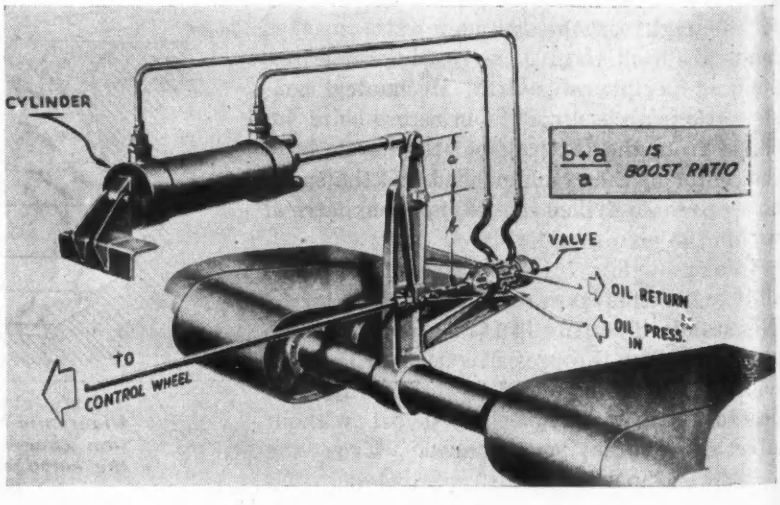
Our thought on the Constellation was always to obtain maximum controllability for all surfaces with minimum drag. We were fortunate in that our studies of hydraulic power booster control systems had progressed far enough to permit its inclusion from the start of the Constellation without compromise. Today, after five years of intensive development, we have solved the many problems brought up in applying the booster to a large aircraft with most gratifying results and I may say that the future prospects are very appealing.

Although there is nothing particularly new in the principle of control boost, it being used for many years in steamships, trucks and even motor cars, application to an airplane presented some new and rather troublesome problems.

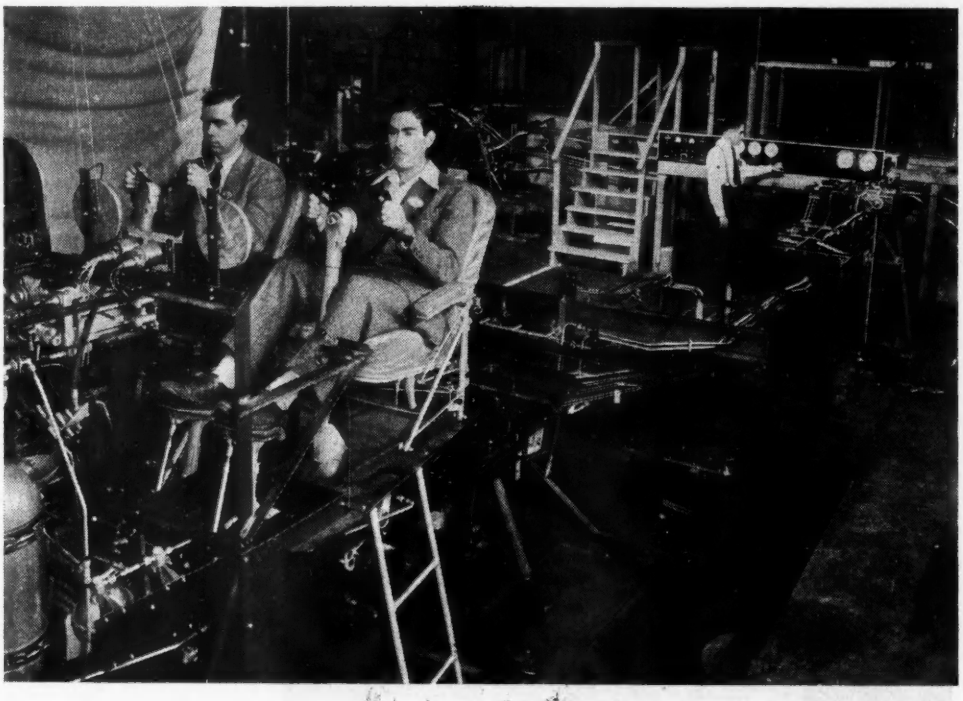
There is a natural objection, to begin with, to having the basic control system of an airplane complicated by the introduction of mechanical devices. It was necessary to provide independent standby units to give control after failure of the basic element. Perhaps most important from the standpoint of an airplane was the necessity for obtaining close balance between control feel, stability and flutter factors on one hand, and reliability, weight and simplicity on the other.

The decision to use a control surface booster on the Constellation was made only after a very complete study of all the factors involved. The advantages which would be obtained if such a device could be successfully developed were these:

1. For a given control surface area, maximum control could be obtained, surpassing that obtainable with any type of aerodynamic balance



Basic design features of the Lockheed hydraulic booster.



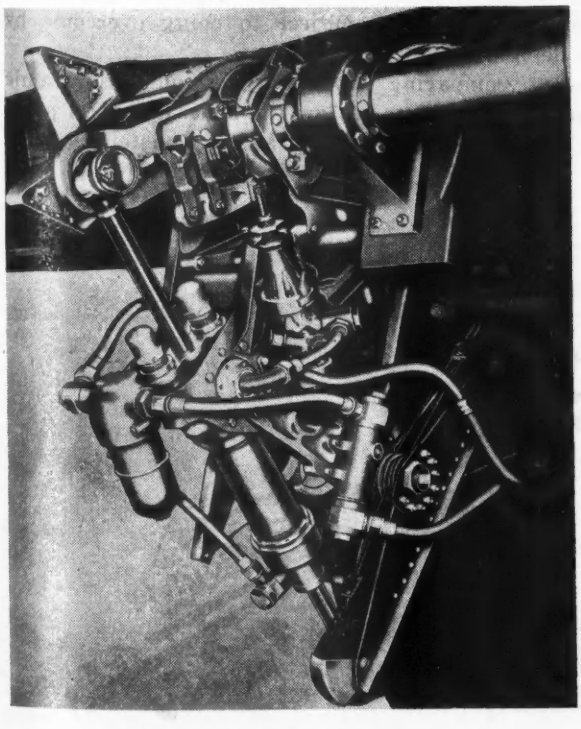
Laboratory full scale working model of control and hydraulic system.

By Clarence L. "Kelly" Johnson
Chief Research Engineer, Lockheed Aircraft Corp.

of the Lockheed Constellation

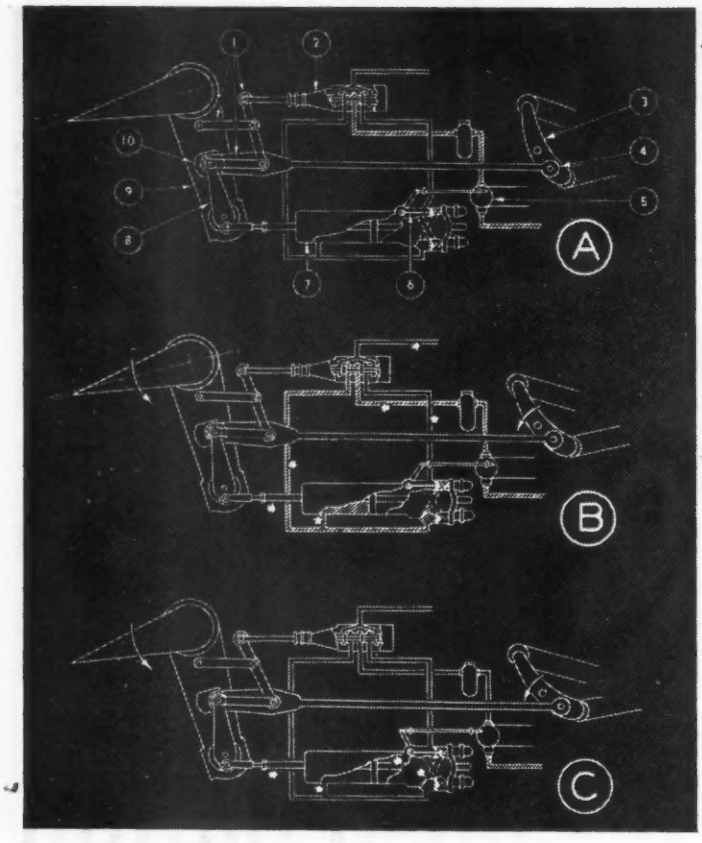
known.

2. For a given maximum controllability the surface equipped with a power booster has from 12 to 30 per cent less minimum drag at cruising and high speeds.



Elevator booster mechanism.

3. Control forces of any given value could be obtained without the danger of overbalance.
4. The control surface equipped with the booster is in no way subject to overbalance in bad icing conditions, and there are no fabric seals to trap water and freeze.
5. The basic control surface shape when no aerodynamic balance is used and a booster substituted is much better adapted to high speed flight where compressibility effects are a factor. Certain balanced types are definitely known to be bad for high velocities.
6. The power booster is the only device which can oppose unfavorable aerodynamic and flutter forces as well as create favorable ones. This feature will be extremely important for ultra high-speed airplanes operating near and in compressibility conditions.
7. The value of the control forces could be changed readily, over night if desired, or even made adjustable in flight within safe limits.
8. The use of a power booster opens the way toward using an acceleration limiter on large aircraft designed to low margins of safety.
9. For a given maximum controllability, the control surface equipped with the booster will weigh less than those with the aerodynamic balance.
10. A control surface equipped with a booster combination can be highly insensitive to manufacturing tolerances and service damage, which is definitely not true for any aerodynamic form giving a high degree of balance.



Schematic diagram of rudder booster system.

VIEW A illustrates the rudder booster mechanism with the rudder approximately 15 degrees to right. The parallelogram linkage (1) is positioned to hold control valve (2) in neutral. Any movement of lever (8) from alignment with rudder-operating arm (9) will open the control valve.

VIEW B illustrates opening of the control valve by force initiated by the pilot. The control cables have rotated walking beam (3) and, by pulling push-pull feel bar (4), have rotated lever (8) about the actuating-cylinder and piston-rod attaching bearing. The rudder moves slightly as the control valve is opened.

Hydraulic pressure is directed by the control valve to the actuating-cylinder, as long as the walking beam is rotated in advance of the rudder-operating arm, or as long as force is necessary to overcome air load on the rudder. Hydraulic pressure, acting upon the cylinder piston, creates a force proportional to that applied to the push-pull feel bar (4) by the pilot. These combined forces move the rudder, and because the pilot must furnish a part of the force to move the rudder, he has a continuous "feel" of the air load on the rudder.

When the movement of the walking beam is discontinued, the hydraulic pressure continues the movement of the rudder-operating arm (9) until the arm is aligned with lever (8) and the valve is thereby returned to neutral.

VIEW C illustrates the operation of the rudder by manual force alone. The cable-controlled shut-off valve (5) has been closed and the bypass valve (6) opened, leaving the cylinder piston free to move. Rotation of the walking beam by the cables has moved lever (8) until it has taken up the lost motion in the oversize hole (10) in the rudder-operating arm. Direct force is then applied in moving the rudder-operating arm and the rudder to the right.

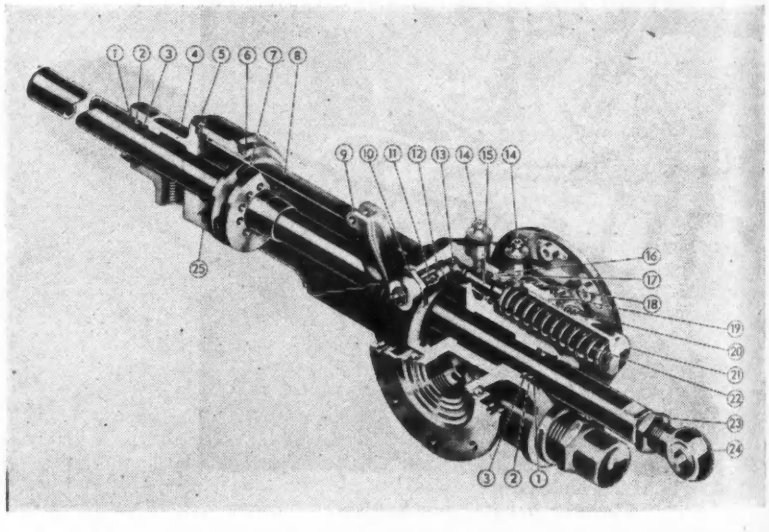
With all of the advantages in favor of the booster, the question arises as to why all airplanes have not been universally equipped with such controls. Both hydraulic and electrical boosters have been and are being used on airplanes other than the Constellation. In several cases they were discontinued as being unsatisfactory. The failure of these booster applications can in all cases be traced to either (1) general service difficulties due to insufficient development, (2) applying the booster as an aid to some form of aerodynamic balancing trying to get it to reduce the hinge moment of the surface only at high deflections, or (3) improper basic design criteria for the booster.

While the basic principles of the booster are extremely simple, there are many highly technical problems which must be overcome to obtain a successful unit. The disadvantages of the control surface booster are these:

1. Necessity to provide automatic stand-by or dual means of operation to account for failure of the basic element.
2. Added complication for service and maintenance.
3. Control cable and booster valve friction multiply the difficulty of the surface finding its free floating angle by the boost ratio used. This is a serious problem in trim and stability.
4. Vulnerability in military aircraft.

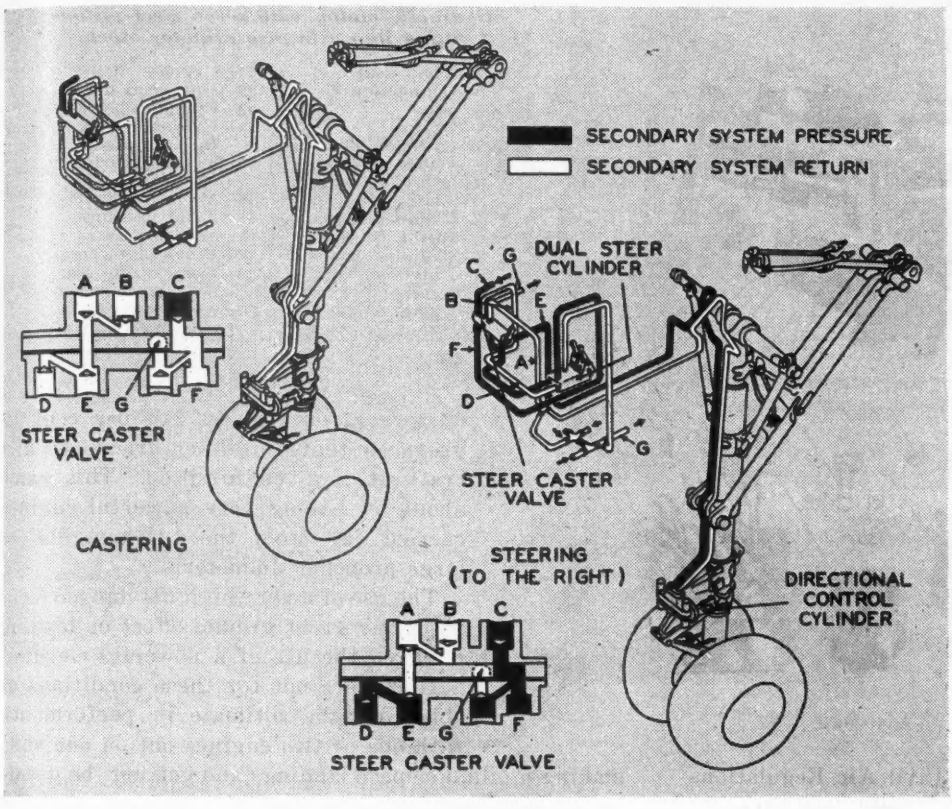
All of the above disadvantages are of a mechanical nature and therefore subject to being overcome by good design.

Before comparing various types of aerodynamic balances, it is well to review the critical control problems on a large aircraft such as the Constellation. In



Booster actuating cylinder

1—Snap ring	14—Valve
2—Scraper ring	15—Valve
3—"O" ring packing	16—Gasket
4—Cap	17—Seat
5—Bolt	18—Nut
6—Nut	19—Packing
7—"O" ring packing	20—Nut
8—Rod assembly	21—Nut
9—Lever	22—Spring
10—Nut	23—Nut
11—"O" ring packing	24—Eye
12—"O" ring packing	25—"O" ring packing
13—Cam	



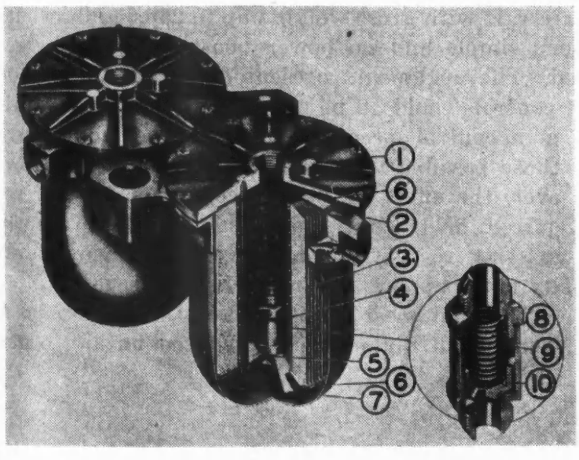
Nose wheel steering system

A—To steering cylinder (LH)
B—From steering valve (LH)
C—Secondary pressure
D—From steering cylinder (RH)
E—From steering valve (RH)
F—To steering valve
G—System return

Critical forces occurred on landing, at minimum two-engine out control speed, and during approach in rough air respectively. Elevator forces on landing down to 35 lb. were tried but found to be too light. The above desirable forces have been obtained on the Constellation, except for the case of the ailerons where a basic friction of five to six ft.-lb. in the system makes it extremely difficult to obtain.

The problem of obtaining these forces may be visualized when it is considered that the horizontal tail area for the Constellation is 10 sq. ft. more than the Electra 10A wing or almost half that of the DC-3. To move one-fourth of this area through an arc of 40 deg. at an airspeed of 90 mph with a force of 80 lb. requires a substantial boost ratio or a very close (and unobtainable) degree of aerodynamic balance.

The Constellation was designed to have the maximum possible control about each axis. The ability to use



(Above)—Main filter units. One filters the primary return fluid; the other filters the secondary return fluid.

1—Cover 2—Gasket 5—Gasket 8—Washer
3—Filter element 6—Gasket 9—Spring
4—Relief valve 7—Plate 10—Piston

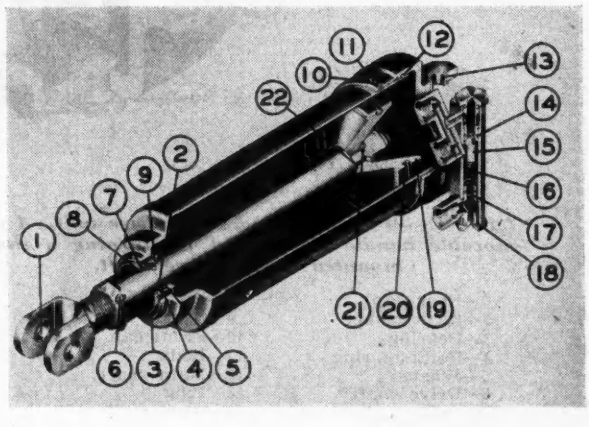
an effort to improve maneuverability with safety, a thorough study was made to find out what control forces a pilot wanted on a large airplane.

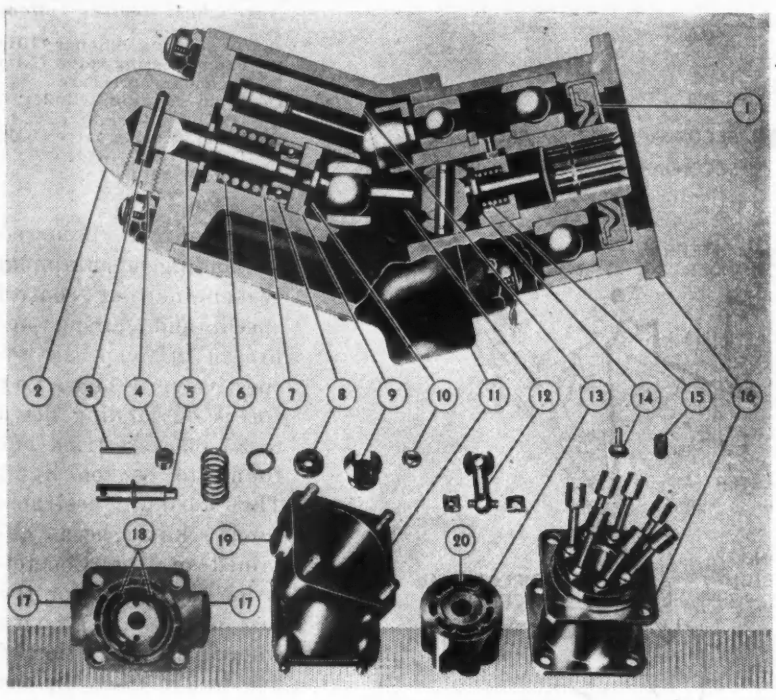
There were no actual values that could be used for design purposes when the booster was first designed, so the units were all made with variable boost ratios (a boost ratio of 19 to 1 implies that the pilot supplies one part of the hinge moment and the booster nineteen parts). After a considerable amount of flying by a number of pilots, the following values were obtained.

ITEM	DESIRABLE FORCE	MAXIMUM OBTAINABLE
Elevator force on wheel at full deflection	50 to 80 lb	160 lb
Rudder pedal—full deflection	150 lb	500 lb
Aileron — partial deflection — one hand	10 ft-lb	35 ft-lb (right) 30 ft-lb (left)

(Below)—Main gear actuating cylinder.

1—Bushing
2—Bearing
3—Snap ring
4—Gasket
5—"O" ring
6—Set screw
7—Snap ring
8—Wiper
9—Bearing
10—Plug
11—Set screw
12—Gasket
13—Bushing
14—"O" ring
15—Shuttle
16—Spring
17—Seat
18—Seal
19—Piston
20—"O" ring
21—Washer
22—"O" ring





Hydraulic motor, with seven steel pistons fitting into a bronze cylinder block.

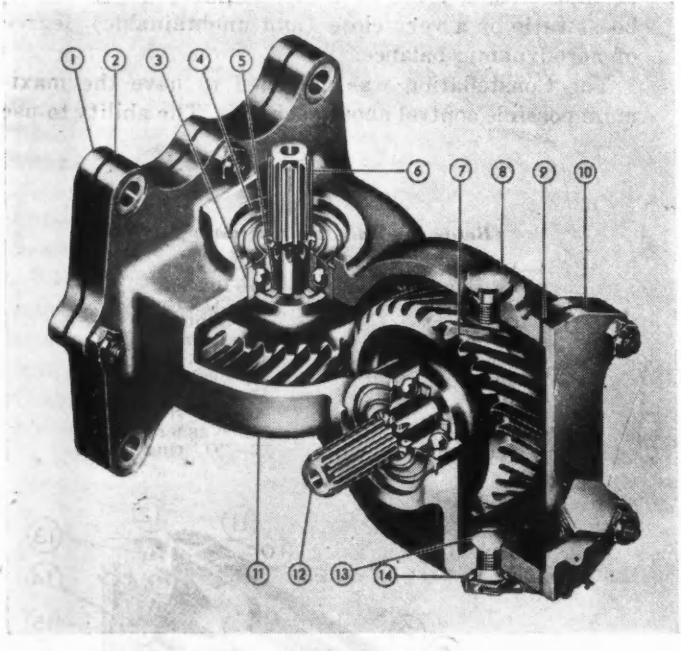
1—Fluid seal
2—Connection cover
3—Pin
4—Plug
5—Cylinder bearing shaft
6—Cylinder bearing shaft spring
7—Cylinder bearing spring retainer
8—Cylinder bearing
9—Universal link retainer
10—Universal link thrust bearing
11—Cylinder housing
12—Universal link
13—Cylinder block
14—Universal link thrust bearing
15—Thrust bearing spring
16—Mounting flange
17—Fluid pressure connections
18—Valve plate ports
19—Case drain connection
20—Cylinder block ports

small fields safely, meeting the Civil Air Regulations (Amendment 56), meant the possibility of carrying more payload in and out of more places and put a premium on good control. The incorporation of very high power in the airplane led to the condition where the rudder and aileron control problem with one engine out was from 180 to 240 per cent as great as that for other transport aircraft at a given airspeed. This came about by having very powerful engines carried far from the fuselage due to large propeller diameter.

The use of a very high lift flap and consequently great ground effect on landing required the use of a powerful elevator.

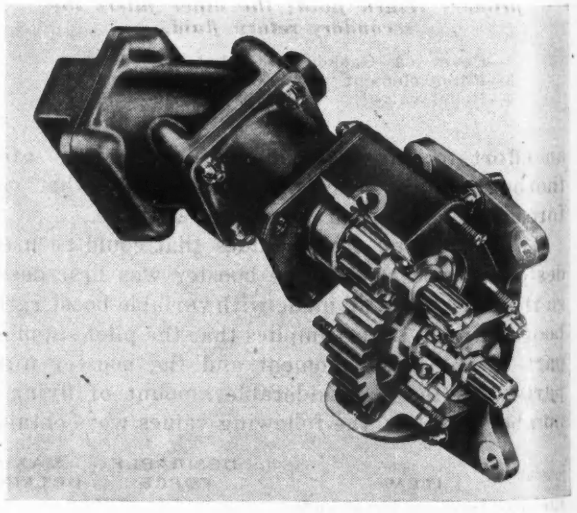
If it were not for these conditions of obtaining the ultimate in performance with one or two engines out on one side, making minimum speed landings and getting the greatest possible control at the stall, the problem of flying any aircraft with gross weights up to 250,000 lb. would be very simple and no power boosters would be required. The arguments presented in this article for boost controls could all be nullified by accepting minimum control speeds 20 or 30 miles per hour above those possible to obtain with the booster. However, the effect of this procedure on safety, required field length, airplane economics under existing regulations, and over-all maneuverability is too apparent to require any discussion.

The final boost ratios used on the Constellation were much higher than any used on any other

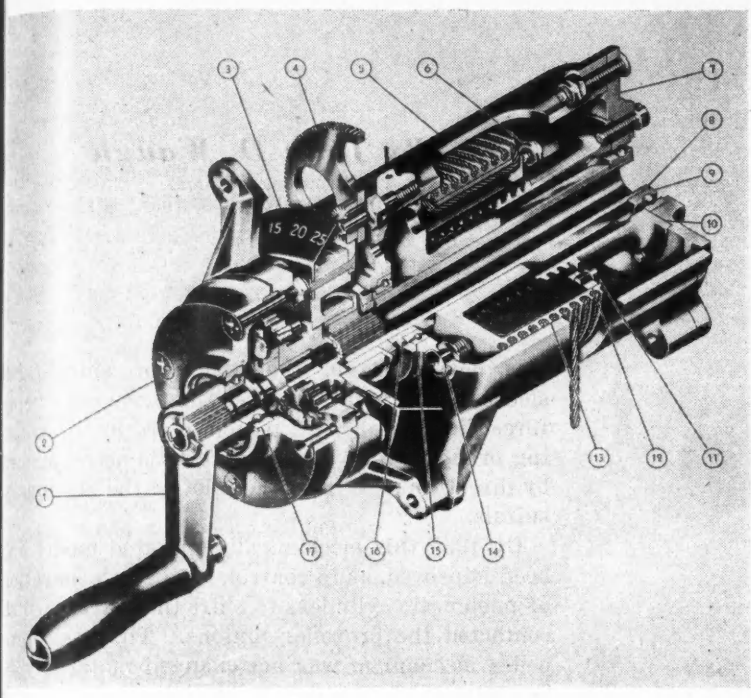


(Above)—Wing flap emergency drive unit. A removable handle is provided for turning a shaft mounted on the drive shaft.

1—Rear cap
2—Rear gasket
3—Bearing
4—Retainer ring
5—Washer
6—Drive shaft
7—Gear
8—Breather cap
9—Gasket
10—Front cap
11—Body
12—Main shaft
13—Plug
14—Gasket



Wing flap main drive unit. It consists of a three-to-one spur gear speed reducer driven by two hydraulic motors.



(Left)
Aileron and rudder tab control mechanism showing liberal use of anti-friction bearings. The two units are similar except for drum stops and positioning of the mounting.

1—Crank
2—Gear box
3—Dial
4—Dial gear
5—Housing
6—Housing cover stop
7—Cover plate
8—Drum shaft
9—Bearing
10—Screw guide
11—Drum stop
12—Drum plate
13—Drum assembly
14—Housing stop
15—Bearing
16—Shaft adapter
17—Bearing

aircraft (generally around three- or four-to-one).

They are:

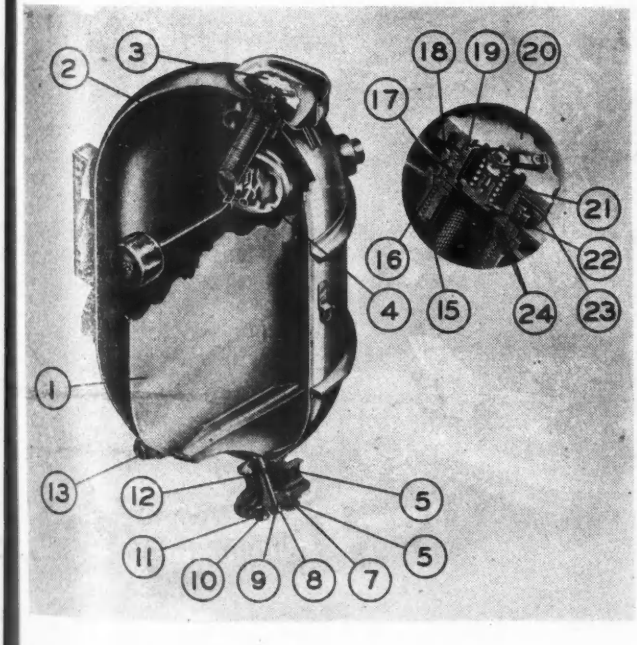
ITEM	FINAL RATIO	RANGE OF BOOST RATIOS TESTED
Elevator ...	9.33 to 1	9.33 to 23
Rudder	23.0 to 1	33 to 1 to 15 to 1
Aileron	26.0 to 1	26.0 to 1

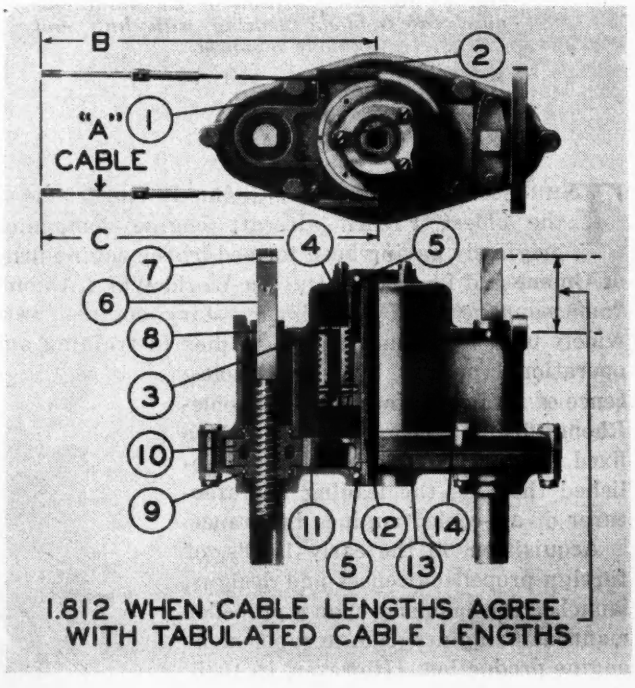
All surfaces utilize a slight amount of servo action on the trim tab to make the above ratios feasible. This does not increase drag, area, or weight. Careful analysis of the basic design requirements for booster systems in general was made, with the following conclusions:

(*Turn to page* 96, *please*)

(Below)—Hydraulic reservoir. It is divided into two equal compartments by a vertical baffle extending about two-thirds the height of the tank. One compartment stores the primary fluid, the other the secondary fluid. The air space above the baffle is pressurized by an aspirator. The tank capacity is 6½ gal.

1—Baffle partition
2—Filler screen
3—Filler cap
4—Liquid level position transmitter
5—Suction fitting
6—Plug
7—Gasket
8—Bolt
9—Washer
10—Plug
11—Gasket
12—Gasket
13—Suction fitting
14—Dip stick
15—Filler
16—Gasket
17—Gasket
18—Nut
19—Sleeve
20—Cap
21—Spring
22—Valve
23—Set screw
24—Gasket





(Above)—Tab operating mechanism.

1—Retainer
2—Wiper
3—Drum assembly
4—Screw
5—Drum bearing
6—Screw assembly
7—Bushing
8—Bushing
9—Screw bearing
10—Screw gear
11—Drum shaft gear
12—Drum shaft
13—Cap assembly
14—Case assembly

Cable lengths

Used on	B	C
Aileron tab	130	130
Elevator tab	48	48
Center rudder tab	265	268
Outboard rudder tab	81	81

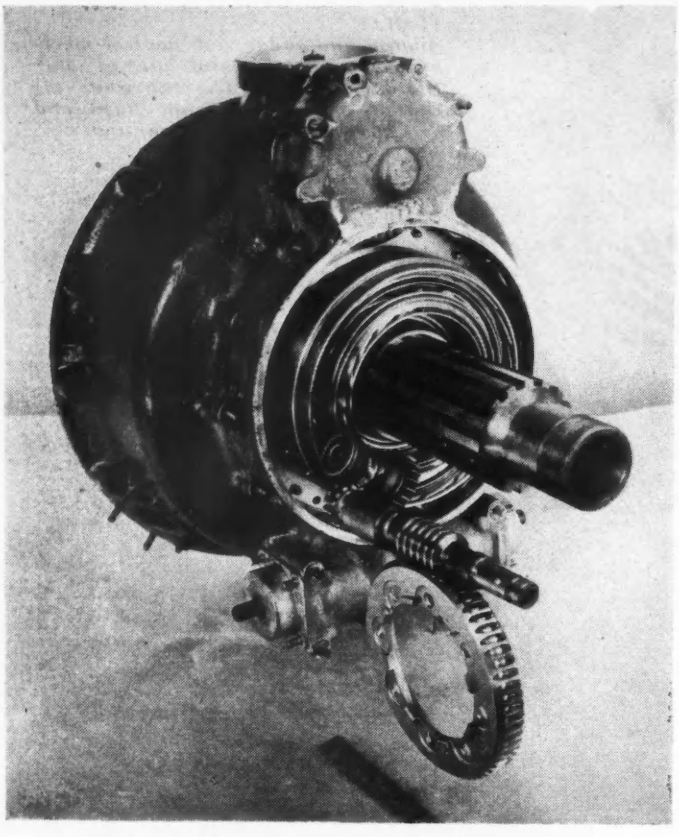


Fig. 1—Relative position of Gnome-Rhone nose case-to-blade gearing with hub and blade removed.

By John D. Waugh
Propeller Division,
Curtiss-Wright Corp.

THE Société des Moteurs Gnôme-Rhône is one of the oldest French aircraft engine companies, originally having been formed by the engine firms of Gnome and Le Rhone. During World War I, Gnome "monosoupape" and Le Rhone rotary engines were widely used by France and the Allies in training and operational pursuit planes. Obsolescence of rotary engines led the Gnome-Rhone firm to develop and produce fixed, radial engines, which established them as the leading manufacturer of air-cooled engines in France.

Acquisition, in the early 1930's, of foreign propeller licenses and designs, launched the company upon a propeller manufacturing program to supplement engine production. However, in 1935. an original propeller design was announced by Gnome-Rhone. This design consisted of a manually controlled, mechanically-operated unit. The source of pitch-changing power was derived from the action of spiral-faced sleeves on the stationary engine nose case being forced into mesh with pinion gears in the rotating propeller hub. This action was accomplished by direct linkage from the pilot to the stationary spirals.

By 1938 this mechanically-operated model had been improved, as to control, by the incorporation of pneumatic cylinders to shift the spirals which contacted the propeller pinions. The basic propeller mechanism was not changed materially in the later design, although a pitch indicator had been added.

A three-bladed model which is to be described, bears a manufacture date of June, 1939, and was installed on a Gnome-Rhone 14M engine bearing the date Deccember, 1939. This 650 hp engine is of the same type as that used by the Germans on their Henschel 129, low-level, attack-bomber. To supply the engines, the Germans kept the Gnome-Rhone factories open until they were bombed shut, but apparently did not prefer to install many Gnome-Rhone propellers on the Henschels. Most Henschel installations were found to have Ratier electrically-operated propellers. Until Paris was taken, Ratier propellers were being made, even in German requisitioned subways.

The entire gear train operation may be determined from Fig. 1, which shows the blade drive gearing with

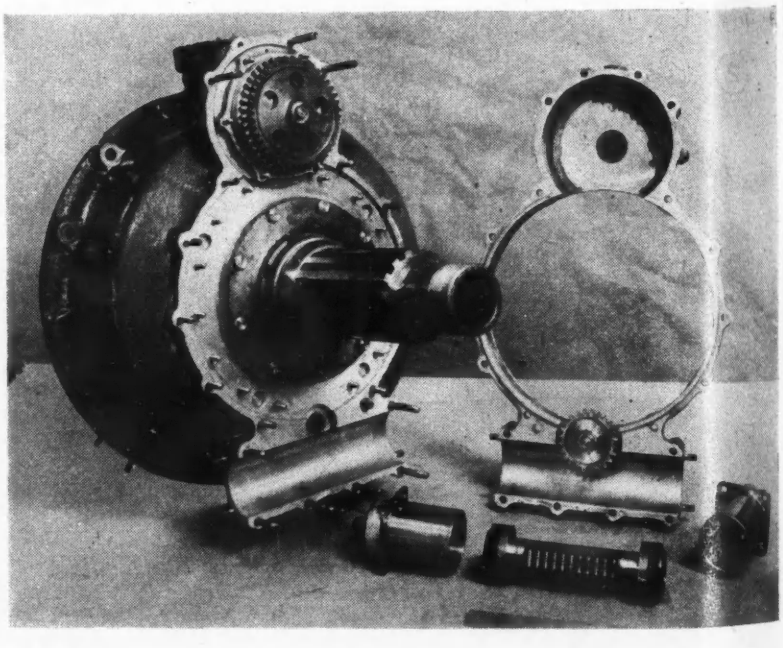


Fig. 2—Nose case with spiral housing and pneumatic actuator exposed.

The French Gnome-Rhone Mechanically Operated Propeller

the hub removed and the gearing in relative position to the engine nose case and fixed spiral mechanism. Mounted on the engine nose case is a housing containing, in its lower section, two opposed pneumatic cylinders enclosing a toothed shaft having piston ends. Admission of air to either cylinder will cause the shaft to move in the direction of the opposite cylinder. The shaft teeth mesh with a spiral-actuating ring gear, secured to the fixed spirals, which are actually helically-mounted sleeves having a spiral tooth on the forward end.

As air is directed to one of the cylinders, by pilot selection with a small valve, the toothed shaft moves across, rotating the spiral-actuating ring gear and causing one spiral to be projected and the other withdrawn. The projected spiral engages a transverse pinion mounted on the rear of the hub. Each revolution of the propeller causes the pinion to travel around the fixed spiral and rotate one tooth on its shaft. Integral with the transverse pinion is a small worm in mesh with the pinion gear of the blade drive worm.

The blade drive worm is parallel to the propeller shaft and in mesh with the blade worm wheel. Thus, rotation of the transverse pinion and worm will revolve the blade drive worm and complete the train to the propeller blades. When a pitch change in the opposite direction is desired, air is admitted to the other cylinder and the previously withdrawn spiral emerges to engage the pinion. The tooth of this spiral is cut in a reverse direction to that of the first, so an opposite direction of pitch change may be obtained. Centering springs are fitted in each cylinder so that when no pitch change is desired, both spirals will be withdrawn from the hub gearing.

Fig. 2 is a view of the engine nose case with the spiral housing and pneu-

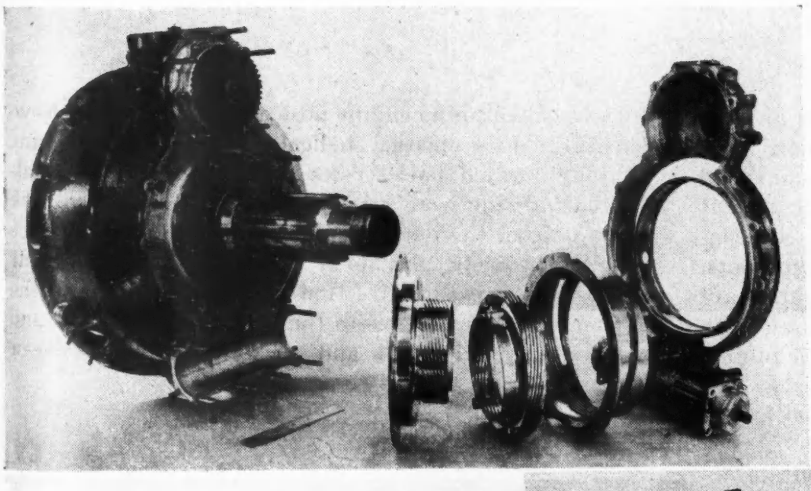


Fig. 3 — Inner and outer spirals, sleeves, and pneumatic actuator assembly.

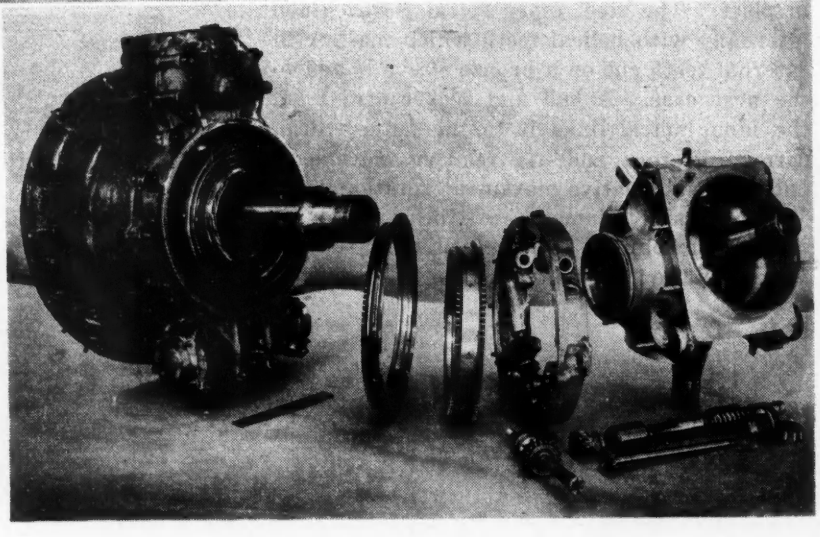


Fig. 4—Nose case mechanism installed with exploded hub gearing in relative position.

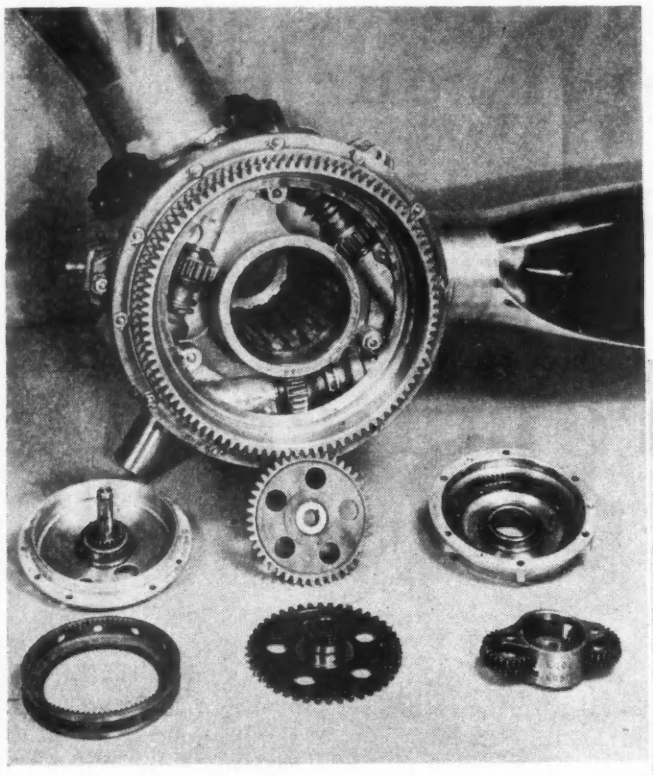
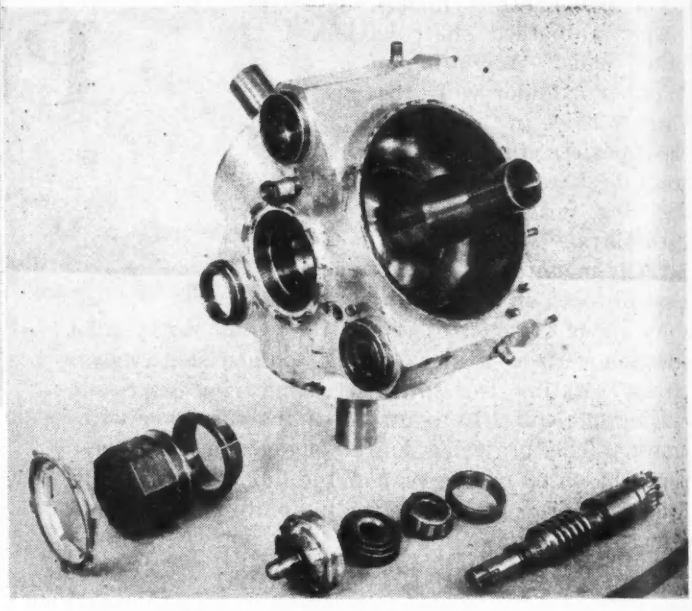


Fig. 5 (Left)—Hub gearing in place on the hub with pitch indicator system exploded.

Fig. 6 (Below)—Gnome-Rhone hub, retaining parts and blade drive worm assembly.



matic actuator exposed. The nose case is machined to receive the housing and includes half of the cylinder channel; the other, half being formed by the housing. Pitch indicator gearing is fitted at the top of the nose case so that it will coincide with gears on the hub.

Plain bronze bearings, one in the nose case and the other in the housing, support an intermediate gear placed between the teeth of the piston shaft and spiral actuating ring. The teeth of the piston shaft are cut integral with the shaft. The pistons at each end consist of steel guides, leather washers and ring nuts. The cylinders to which they are fitted, tightly, are made of single pieces of steel and are equipped with connections for the attachment of the pneumatic tubing.

Fig. 3 shows the inner and outer spirals with their sleeves and the pneumatic actuator assembly with the spiral-actuating ring gear in place. The steel inner spiral is machined internally with helical teeth which mate with external teeth cut on a bronze sleeve bolted to the nose case. A ball and socket arm from the inner spiral links it to the outer spiral, permitting fore and aft relative movement, but restricts relative movement rotationally.

The outside diameter of the steel outer spiral is machined with helical teeth, cut to mate with the internal teeth of an outer bronze sleeve bolted to the engine nose case. This outer sleeve features two opposed helical slots, cut in its rim, through which two screws project from the spiral-actuating ring gear. As the ring gear is rotated back or forward, the outer sleeve forms a bearing surface while the slots provide a guide for the ring gear pins. The opposite direction of the helical teeth of the inner spiral and sleeve to that of the outer spiral and sleeve, with the ball and socket link pin between

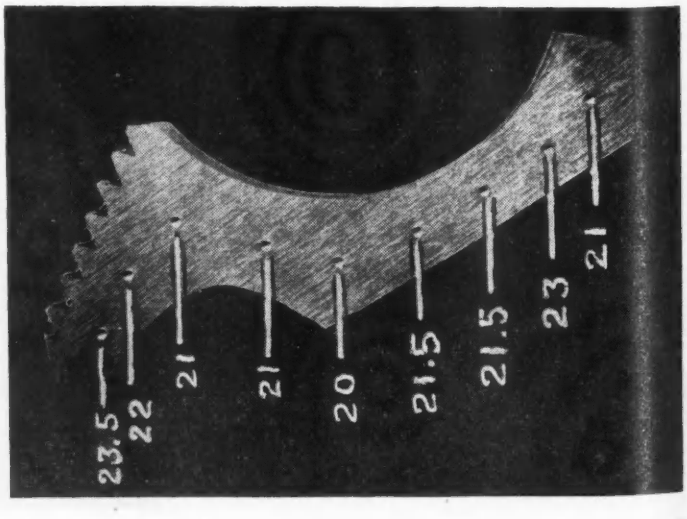


Fig. 7—Rockwell "C" hardness readings of Gnome-Rhone hub wall.

Fig. 9—Cutaway hub with two blades installed. Third blade assembled and in foreground.

spirals, causes one to withdraw when the other is projected by ring gear movement. The machine work on all parts of this assembly was well done and the operation was smooth.

Hub Gearing

The gearing which is contacted by the nose case spirals and the gearing from the blade drive worm to the pitch indicator is mounted on the rear of the hub. A cast dural housing forms a frame to hold the three transverse pinion gears. Each end of the pinions is fitted with a ball thrust bearing and a shaft is pressed through the center into bosses in the housing. Fig. 4 shows the hub gearing exploded and in relative position to the engine nose case.

A fixed ring gear, bolted to the hub gear housing, encloses a moveable sleeve gear having teeth on its outer circumference at the front and rear edges. The teeth at the front, or hub edge, mesh with a gear projecting from the blade drive worm. This gear may be seen, with its long shaft, in Fig. 4. The rear teeth mesh with a gear of the epicyclic pitch indicator gearing in the engine nose case. The teeth of the fixed gear also mesh with a pitch indicator gear to provide a drive at hub speed.

In operation, when no pitch change is taking place, the fixed and moveable gears rotate the first stage of the pitch indicator gearing at a condition of balanced speeds. When a pitch change is taking place, the blade drive worm moves, rotating the sleeve gear and pitch indicator gear at a relative speed different from that of the fixed gear rotating at hub speed. This discrepancy in speeds, through the action of an odd number of teeth between the stages of the pitch indicator gearing, causes the drive from the gearing to the indicator to rotate in proportion to the pitch change. The pitch indicator gearing, shown in Fig. 5, is a compact unit, 5½ in. in diameter and 2 in. thick. All bearings are plain bronze or dural and showed little wear, as did the gearing. Lubricating oil from the engine reduction gearing gained admission through a passage in the nose and holes in the gear case.

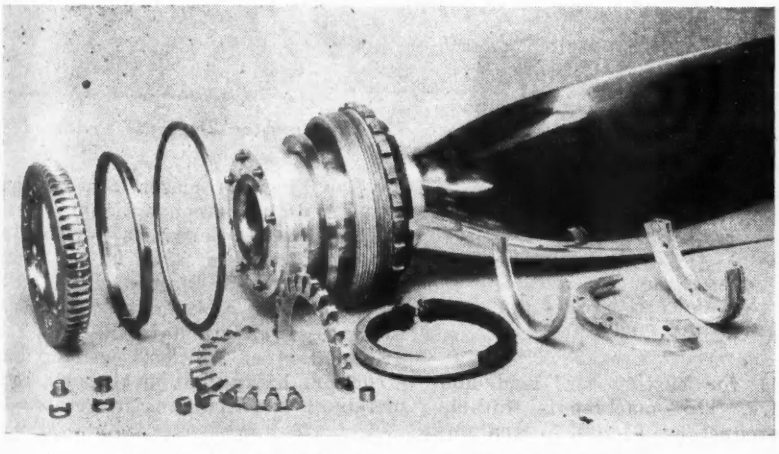


Fig. 8—Blade with blade retention and drive assembly.

The Hub

The Gnome-Rhone hub, shown in Fig. 6, is fabricated in one piece from a chrome-nickel alloy steel forging. Spider arms, integral with the hub, extend from the base of the hub socket to several inches outside the socket rim. The inner edge of the socket rim is V-threaded to receive the blade retaining nut. A boss between each socket houses the blade

(*Turn to page 78, please*)

Spectrographic Analysis of the Hub

Elements Present	Traces Present
Nickel	Vanadium
Molybdenum	Aluminum
Chromium	Copper
Manganese	
Silicon	

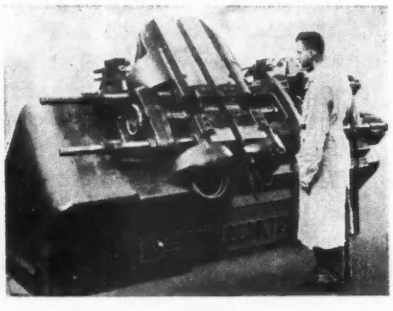
Chemical Analysis (%)

Copper	0.36
Manganese	0.23
Phosphorus	0.004
Sulphur	0.022
Silicon	0.21
Chromium	0.77
Nickel	2.37
Molybdenum	0.03

New Production Equipment

A LINE of butt-flash welding machines in five standard sizes embodying new design and operating features has been announced by Progressive Welder Company, Detroit, Mich. The machines range in electrical capacities from 20 kva to 250 kva. The five basic sizes, which comprise this range, are classified and rated according to recommended specifications of the Resistance Welder Manufacturers Association.

The design of these machines permits them to be furnished for hand, air, hydraulic or motor operation, as desired. Work clamping fixtures can be operated by one method and platen



Progressive butt-flash welding machine

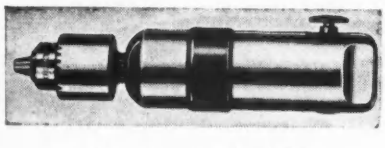
traverse by the same or another method. Thus, work clamping can be air operated and the flash and upset can be hydraulically operated on the same machine without change in the basic design of the machine. According to the nature of the work to be done, a machine may be manually controlled, semi-automatic or fully automatic.

EIGHT new drills have been added to the Aro line of pneumatic tools by The Aro Equipment Corp., Bryan, Ohio.

These drills are of 3/16 in. and ¼ in. capacity, especially suited to assembly operations where they contribute greater speed and efficiency to production. Their design embodies features for powerful, stall-proof operation, combined with light-weight construction.

Model 209 with button throttle, and Model 309 with lever throttle, have aluminum housing, 3/16-in. or ¼-in. chuck, and weigh 1 lb, 13 oz. These are straight-type drills, 2500 rpm.

Model 2013 is similar to Model 209, except that it offers a speed of 4000 rpm. Likewise, Model 3013 is similar to Model 309, with 4000 rpm.



Aro pneumatic drill

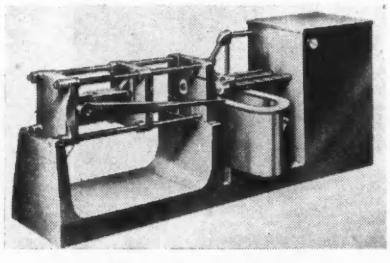
Model 2010 with button throttle, and Model 3010 with lever throttle, operate at 2500 rpm. They have aluminum housing and handle, 3/16-in. or ¼-in. Jacobs chuck and chuck guard. Weight 2 lb, 1 oz.

Model 2014 is similar to Model 2010, except speed is increased to 4000 rpm. Model 3014 is similar to Model 3010, with a speed of 4000 rpm.

Standard equipment with all eight models includes 8 ft of ¼-in. hose with ⅛-in. and ¼-in. male fittings on ends.

H. L. HARVILL MANUFACTURING CO., Vernon, Cal., is releasing information on the first of four new die casting machines which range in complexity from a manual die opening and closing machine in which air injection is employed, to a fully automatic cold chamber machine for high production of aluminum, magnesium and bronze alloys.

The first of the new series of machines to be announced is the Model

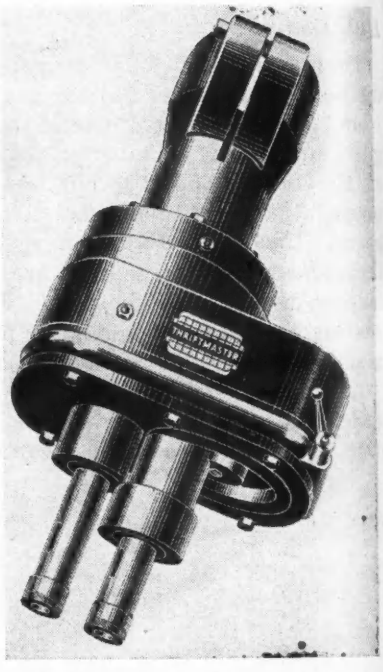


Harvill Model HD-1AM1 die casting machine

HD-1AM1 for casting tin, lead and zinc alloys. This machine is suitable for the production of small to medium-sized castings. It embodies metal injection and operating features normally found only in larger and more expensive equipment, excepting that the operation of the movable die platen is accomplished by a hand lever. Production output is controlled by the physical capacity of the operator of the machine, production rates of 300 to 400 cycles per hour having been attained by efficient personnel without undue physical exertion.

The HD-1AM1 machine will accommodate dies having a vertical dimension of 8 in. and a horizontal dimension of 12 in. The travel of the movable platen permits a dimension of 6¼ in. between the die faces, the dies having a maximum thickness of 14 in. Construction of the die mounting platens permits dies of greater horizontal dimension, provided that the cavity arrangement allows for metal flow. When oversize dies are used, the die itself overhangs the platen and, if excessive in weight, requires auxiliary support.

THRIFTMASTER PRODUCTS DIVISION of Thomson Industries, Inc., Long Island City, N. Y., is augmenting its drillhead production by a two-spindle offset-type drillhead in which one spindle is built integral with the drive shaft and the other is offset and adjustable for variable centers. This per-



Thriftmaster 2-spindle drillhead

mits drilling on closer centers than possible with the conventional type in which both spindles are ajustable. The three most popular sizes have spindles provided with ¼-in. capacity chucks, No. 1 or No. 2 Morse taper and are available from standard designs. This drillhead is of full ball bearing construction, having all vital parts completely enclosed running in grease.

TO FACILITATE the loading of heavy work in straightening presses, Anderson Bros. Mfg. Co. of Rockford, Ill.,

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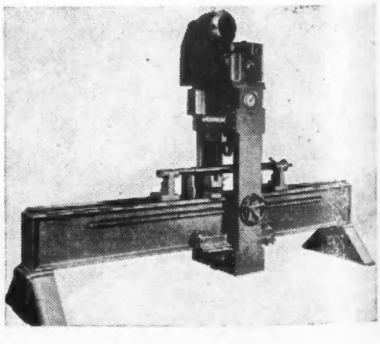

Anderson press

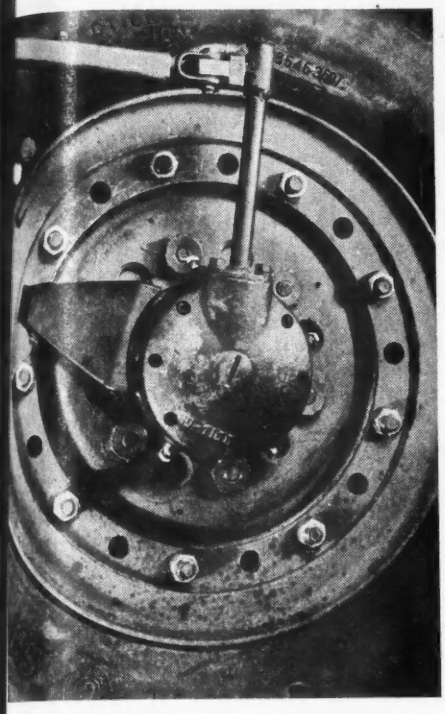

Fig. 1—Exterior view of special hub.

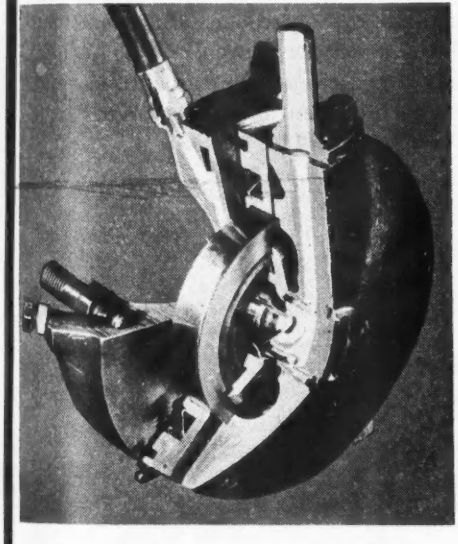

Fig. 2—Cutaway view of hub showing rotating pressure joint.

Special Hub

is Crucial Unit in Army Duck

Tire Inflation

SATISFACTORY functioning of the centrally-controlled tire inflation system, with which the Army Duck vehicle is equipped to enable the driver to inflate or deflate any or all tires while it is stationary or moving at full speed on land or in water, was made possible by designing a special hub mechanism in the form of a rotating pressure joint. This system, developed by the GMC Truck & Coach Division of General Motors, was adopted early in 1943 after several experimental set-ups were tested and has been incorporated in all of these amphibious vehicles built since that time.

The hub consists of two major parts—an inner member that rotates with the wheel and the outer stationary member that is restrained from turning by a flexible strut arm (see Fig. 1) attached to the body of the vehicle. The air hose connecting the air line and hub is carried within the strut and thus is protected by it.

Within the rotating joint (Fig. 2) is an air seal. This is located at the point where the hardened-steel nose piece of the rotating member is in contact with the plastic disk of the outer or stationary member. By accurate grinding of the nose piece and a fine adjustment of the plastic disk an air-tight seal is obtained. A special, precision, heavy-duty ball bearing maintains close alignment between

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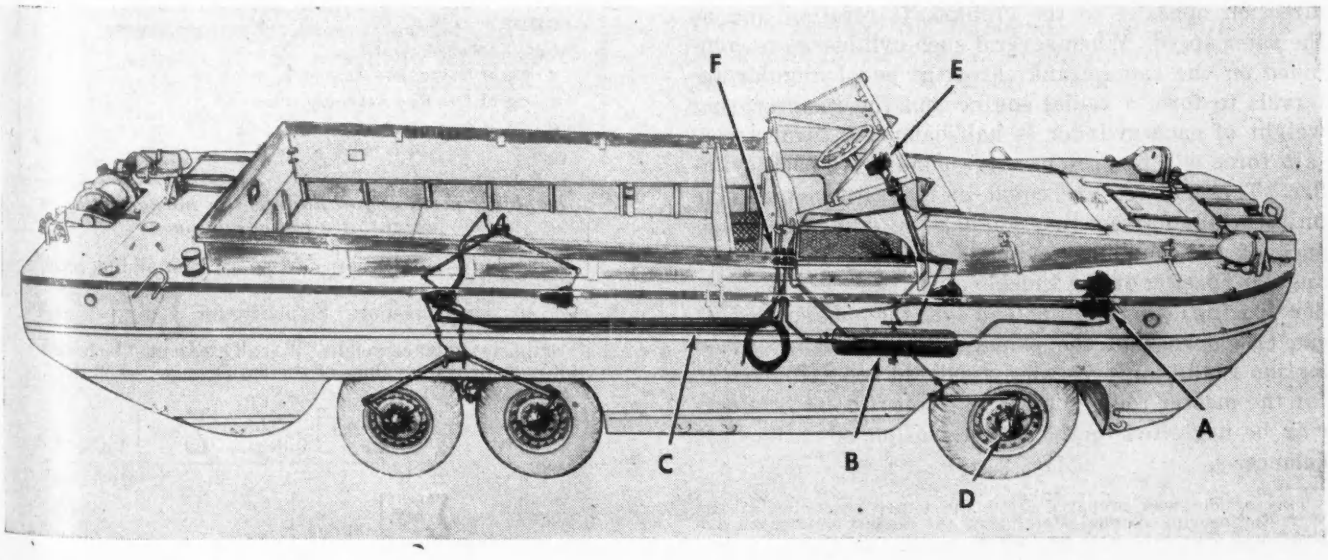

Phantom view of Army Duck vehicle showing central inflation system developed by GMC Truck & Coach Division of General Motors Corp. Its essential units are: (A) Air compressor pump, located toward the front of the engine, and running constantly with it; (B) Compressed air storage tank; (C) Air lines from the air reservoir to the wheels; (D) Rotating pressure joints attached to each wheel hub; (E) Tire pressure gage and inflation control lever on the instrument board; (F) Control valves for each of the six air lines carrying air to the tires.

Discrepancies

In primary balancing of Radial Engines

By G. L. Williams
Analytical Engineer,

and A. B. Miller
Assistant Project Engineer,
Pratt and Whitney Aircraft,
Div. of United Aircraft Corp.

IN THE determination of correct counterweight size for radial engines, a certain method has had such widespread use that it is generally considered conventional. This "conventional" method may be briefly summarized as follows: 1. Weighing of rotating and reciprocating parts; and 2. Addition of one-half the sum of the reciprocating weights to the sum of the rotating weights to obtain a "master balance weight," an imaginary weight acting at the crankpin and equivalent to the connecting rod and piston system for balancing purposes.

The division of connecting-rod weight between rotating and reciprocating portions is ordinarily accomplished by supporting the rod horizontally on two knife edges placed in line with the axes of the bores of the ends of the rod and weighing the reactions. This operation, in effect, replaces the rod by two concentrated masses located at opposite ends of the rod on the bore centerlines. It can be shown that for balancing purposes such a substitution is an exact equivalent.

This method has found wide acceptance because of its simplicity and its apparent accuracy. If the assumption is made that all the pistons have similar motion then it is quite easily proven that one-half the reciprocating weight should be balanced. It is well known that when the reciprocating weight of a single-cylinder engine is half-balanced that an unbalance results which consists of a constant force rotating in a direction opposite to the crankshaft rotation and at the same speed. When several such cylinders are combined on the same crank throw at equal angular intervals to form a radial engine and the reciprocating weight of each cylinder is half-balanced, then, a certain force will be present corresponding to each cylinder. These forces are equal in magnitude and have uniform angular spacing so that the resultant unbalance of the combined cylinders is zero. With even angular spacing of the knuckle pins (same as the cylinder spacing) in the "big end" of the master rod, it can be shown that the primary component of piston motion is the same for all articulated rod cylinders as for the master rod cylinder; so, the articulated effects may be neglected in the determination of crankshaft balance.

This article was prepared from the paper presented at the War Engineering-Annual Meeting of the Society of Automotive Engineers, Jan. 8-12, 1945, at Detroit.

At the Liege Congress of General Mechanics in 1930, a paper was presented by Professor Albert Coppens of the University of Louvain. This paper deals with balancing of engines and derives a formula for the determination of the correct counterweighing of radial engines. This formula does not agree exactly with the "conventional," giving a somewhat higher value for the required counterbalance. This difference in results is stressed in his later paper entitled, "Improved Formula for Computing Counterweights of Single Row and Double Row Radial Engines," delivered at the International Automotive Engineering Congress at Chicago in September, 1933, and published in the *SAE Journal* for March, 1934. Actually, Professor Coppens would use a master balance weight equal to what has been conventional plus a small addi-

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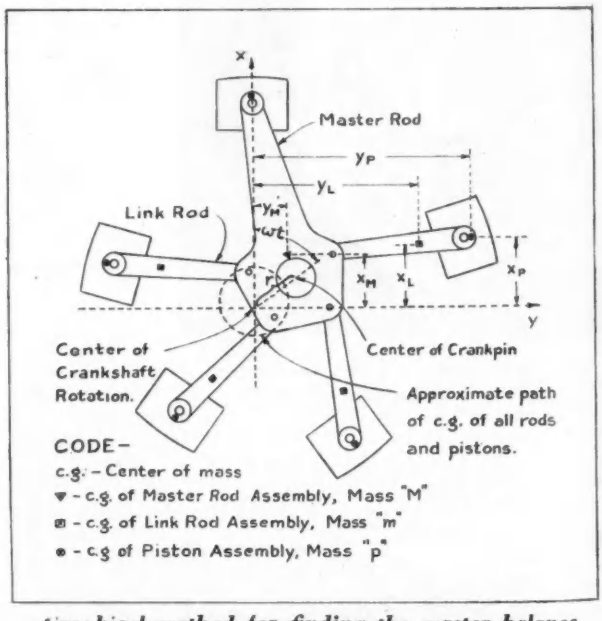

Graphical method for finding the master balance weight of a radial engine

$\sum mx\Big]_{\omega t}$ = summation of Mx_M, mx_L, for all link rods, and px_p for all pistons. Similarly, for $\sum my\Big]_{\omega t}$.

For master balance weight "W", all c.g.'s must be found for each of three values of the crank angle, ωt, 0 deg., 90 deg. and 180 deg.

$$\text{Then, } \frac{W}{g} = \frac{1}{2r}\left\{\frac{\sum mx\Big]_{0\text{ deg.}} - \sum mx\Big]_{180\text{ deg.}}}{2} + \sum my\Big]_{90\text{ deg.}}\right\}$$

did you ever see DIRT before?

THIS is what it looks like, magnified 100 times. Sharp flint-like, often germ-laden.

Unfortunately, your products, machinery, merchandise or even customers and workers find dirt harmful—and without the help of a microscope.

Wherever people, machinery, materials and processes are exposed to air, they are subject to the effects of air-borne dirt—infection, abrasion, contamination and the like.

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ENGINEERED AIR FILTRATION
• Oil bath type filters and filter-silencers • Cleanable filter panels for air-borne dirt, oil, grease and liquids • Oil-wetted type filters and filter-silencers
• Exhaust spark arresters • Gear case, crankcase and tank vent breathers
• Oil-separators for engine crankcases • Full-flow type cleanable oil filters

New Products for Aircraft

Oil Filter Kit

An oil filter kit of type made by Jacobsen & Company, New York, N. Y., for the Air Technical Service Command, is said to overcome difficulties with gravity oil feed in overhauling airplane engines on the test stand. The kit provides the required oil pressure and, by filtering the oil, eliminates dirt in the engine line and the subsequent possibility of bearing failure. The kit includes 3 hp engine, filter assembly and two gages. Oil is pumped from the weigh tank through the assembly, which filters down to six microns. The first gage indicates the pressure necessary to force oil through the filter; the second gage shows the drop across the filters and pressure to the engine oil pump inlet.

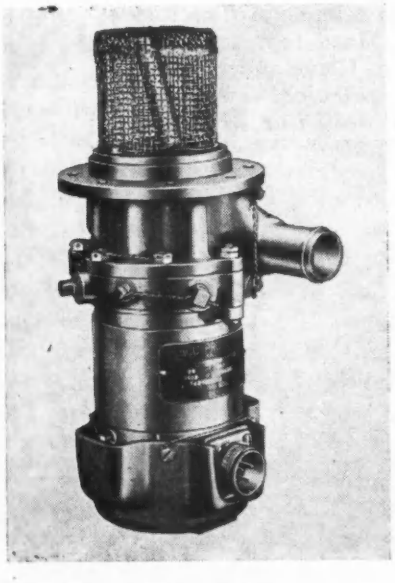
Booster Pump Delivers Bubble-Free Fuel

The increased engine power, faster climb and higher altitude capabilities of modern aircraft have given rise to a demand for a fuel booster pump having more positive vapor separating characteristics to handle the larger fuel flow under the more severe operating conditions.

To meet this demand, Pesco Products Co., Cleveland, Ohio, has brought out a compact, electric motor-driven, centrifugal pump incorporating a unique design providing outstanding performance in delivering bubble-free fuel. The pump is in volume production and has seen actual use on certain planes.

The only moving element of the pump is a direct-driven impeller-rotor with tapered impeller blades on one side, and with shrouded blades on the other. These shrouded blades in combination with an elliptical housing comprise a vacuum arrangement which draws off the vapor and eliminates it through a discharge port, leaving only solid fuel to enter the fuel line.

Various models are available for external mounting on the supply tank or for internal installation to operate submerged in the fuel. The pump is described as featuring positive vapor-control in rapid climb to high altitudes, stabilized delivery of bubble-free fuel, trouble-free bearing and seal arrangement, self-priming, and ability to pump the fuel tank dry.



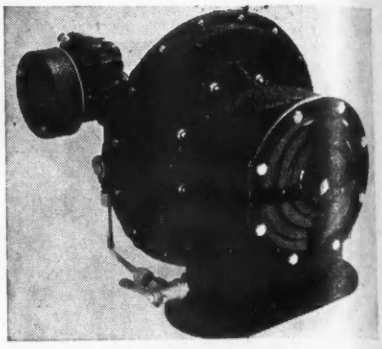
Pesco fuel booster pump

Anti-Collision System Protects Aircraft

Development of an anti-collision system to prevent such crashes as where planes hit mountainsides or other obstructions, or even mishaps between planes themselves, was disclosed by the Panoramic Radio Corp., New York City, and the Kollsman Aviation Instrument Division of Square D Co., of Elmhurst, N. Y.

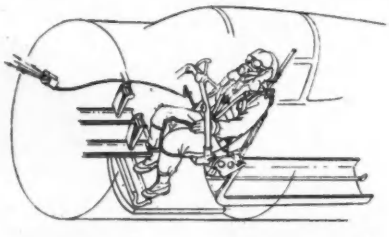
The anti-collision system is known as the stratoscope. It is not radar in principle, but embodies principles of radar operation and the use of a sensitive aneroid diaphragm altimeter similar in type to those which are standard navigational equipment on present aircraft.

Variable Isobaric Cabin Pressure Regulator



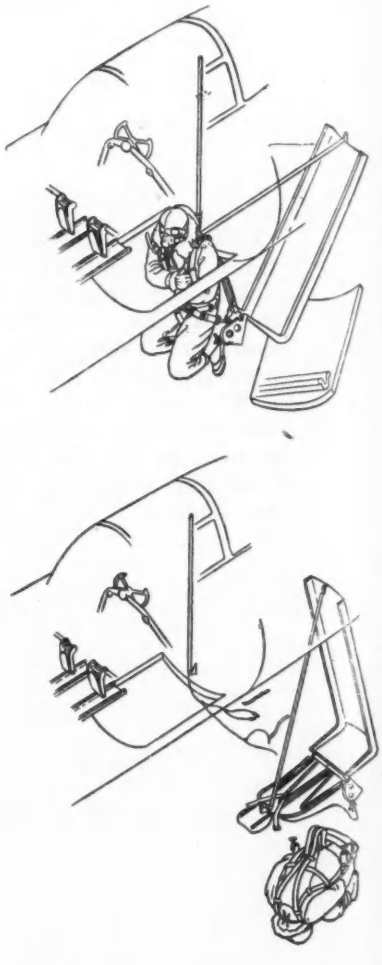
AiResearch Manufacturing Co., Los Angeles, Cal., now has this cabin pressure regulator ready for commercial use. The new device is said to control cabin pressures from sea level up and through all the varying conditions of flight encountered in normal airport to airport travel.

Catapult-Seat for Pusher-Type Plane



(Top left) Pilot lowers seat and presses release lever.

THE "catapult seat," developed at Consolidated Vultee, is a sort of miniature elevator operated by an electric motor. On the ground, it can be extended beneath the fuselage or cockpit nacelle; then when the pilot sits down and pulls a lever it will rise into the cockpit. If no trouble is encountered in flight, the pilot readjusts the seat lever and lowers himself to the ground after landing. If there is a serious flight emergency, the pilot can pull an auxiliary lever and the seat will drop through the bottom and throw him clear of the airplane so that he will not be injured by the propeller. The drawings show how the catapult seat functions in the event of an emergency in the XP-54.

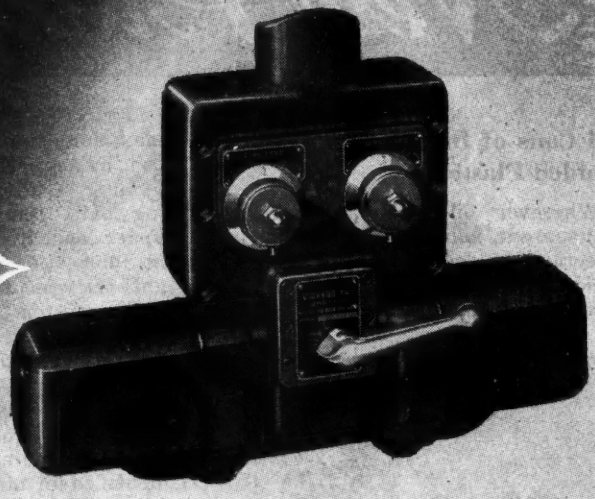


(Top right) Seat drops through bottom of airplane.

(Lower right) Pilot is catapulted clear of airplane structure.

SMOOTH and CONSTANT FEED RATE

regardless of fluctuations in work resistance or hydraulic operating pressure



Double Solenoid Type
Push-button Operation

VICKERS "Traverse and Feed Cycle" CONTROL PANELS

These panels provide self-contained, compact control units for automatic machine applications where the cycle is a combination of rapid advance, one or two feeds, and rapid return motions. The two feed rates are infinitely variable within their ranges, and adjustments can be made during feed. Applications include drilling, reaming, boring, turning, milling and swaging machinery.

The hydraulic circuit in the panel employs the well-known Vickers Flow Control Valve in a "metering-out" circuit which means a smooth and constantly maintained feed rate for any given adjustment regardless of fluctuations in cutting tool resistance or changes in hydraulic operating pressure.

Simplicity is evident from the fact that there are only two working parts that move. Many standard modifications are available; feeds can be in either direction or both directions; operation is by single or double solenoids integral with panel, separate solenoids or pilot pressure. Practically any cycle sequence can be obtained. See Bulletin 41-10 for complete information.

Vickers Application Engineers will gladly discuss with you how "hydraulics" can be used to your advantage.

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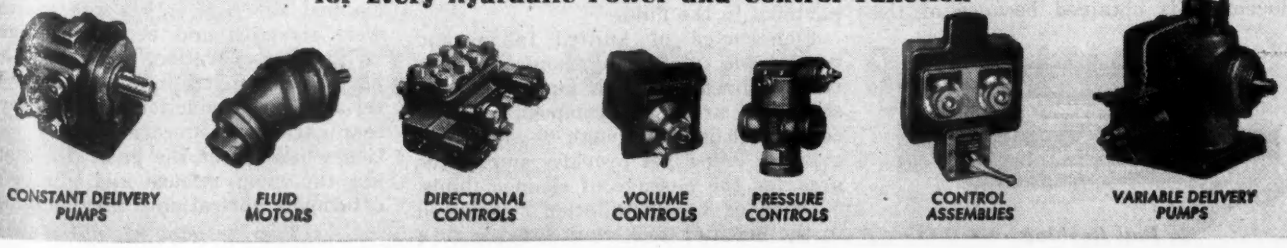
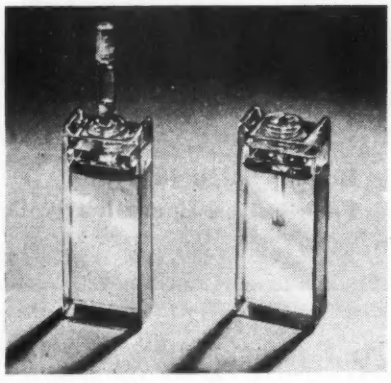


CONSTANT DELIVERY PUMPS · FLUID MOTORS · DIRECTIONAL CONTROLS · VOLUME CONTROLS · PRESSURE CONTROLS · CONTROL ASSEMBLIES · VARIABLE DELIVERY PUMPS

New Products

Oil Cans of Injection Molded Plastic

Wherever oil cans are used, the transparent, non-corrosive can made of injection molded plastic by Standard Molding Corp., Dayton, Ohio, has advantages worth considering.



Plastic oil cans made by Standard Molding Corp.

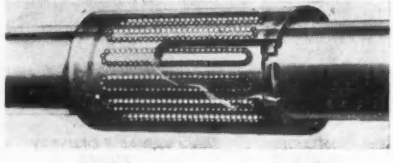
These plastic oil cans have already simplified the job of oiling war equipment under difficult climatic conditions. Designed to pack compactly in minimum space, they are ready for instant use with their contents always visible.

The same features of transparent toughness, non-corrosiveness and compact design should earn the plastic oil can a place as standard equipment in many a peacetime repair kit.

Ball Bushing for Reciprocating Mechanisms

Thomson Industries, Inc., Long Island City, N. Y., has developed a Ball Bushing that permits unlimited travel of reciprocating mechanical members that may be either round or square, or variations of these shapes. The advantages gained from the use of ball bearings for rotating parts can thus now be obtained on sliding members.

The Ball Bushing contains within it a series of ball circuits. One side of the circuit carries the bearing load with the other side returning the balls in a clearance provided in the outer race member of the bushing. Free movement is obtained because of the maximum elimination of friction. The continuous bearing prevents cocking or binding on the shaft because the bearing balls remain constantly centered under load. Rolling contact plus sealed-in lubrication enables a long life of anti-friction precision alignment.

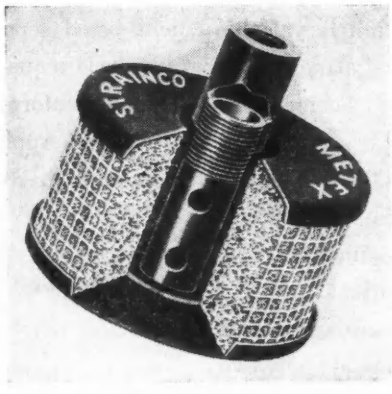


Ball Bushing

The system of ball circuits can be infinitely varied for varying load capacities and shapes of bearing members. Thus it is possible to have a bearing of considerable length or of a square, hexagon or octagonal section. This longitudinal ball bearing is to be identified in marketing with the trade name "Ball Bushing." Results to be obtained from the use of Ball Bushings will be substantial reduction in the size, weight and cost of machinery and equipment.

"Metex" Coolant and Cutting Oil Strainer

A new type of non-clogging coolant and cutting oil strainer for easy installation on grinders, lathes and other machine tools, known as Metex Model G, said to provide cleaner fluids and longer periods of uninterrupted strainer service, has been brought out by the Strainer Products Corp., Montclair, N. J. Preventing chips or particles from being recirculated in the fluids, the strainer units help avoid scoring or other defective work in machine operations. In addition, it protects the circulating pump from chips or other particles in the fluid.



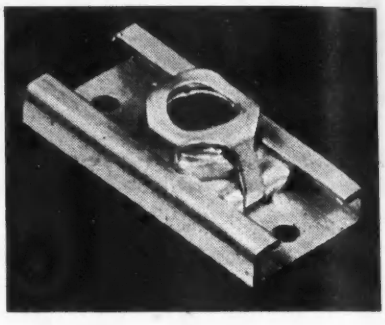
Strainco-Metex Model C coolant and cutting oil strainer

Constructed of knitted fabric and wire, made into strong, non-collapsible rectangular units with unusually high strainage area, the composite honeycomb mesh is fine enough to catch dirt, grit and chips, yet provides ample free area for the passage of cleaned fluids.

Designed for installation submerged in the machine tool sump tank or in a separate tank on the pump intake, Metex Model G is available in six sizes, surface straining areas and capacities. They are made with three or six individual straining elements which feed through a plenum and are interchangeable as to length. Clean strainer refills can be installed in the secure slots in a matter of minutes, and the old ones washed out for another long period of service.

Floating Anchor Nut in Wide Range of Sizes

The Kaynar Manufacturing Co., Los Angeles, Cal., has placed on the market a floating anchor nut which is said to be the only anchor nut employing replaceable standard nuts. It is offered in sizes from No. 6-32 to ⅜ in.—24.



Floating anchor nut made by Kaynar Manufacturing Co.

The unit consists of base, retainer, standard nut, and a steel spring clip, all assembled. The clip holds the nut securely in place, but can be easily disengaged by prying up with an ordinary screwdriver, permitting quick replacement of damaged nuts, without special tools and without need for drilling out rivets.

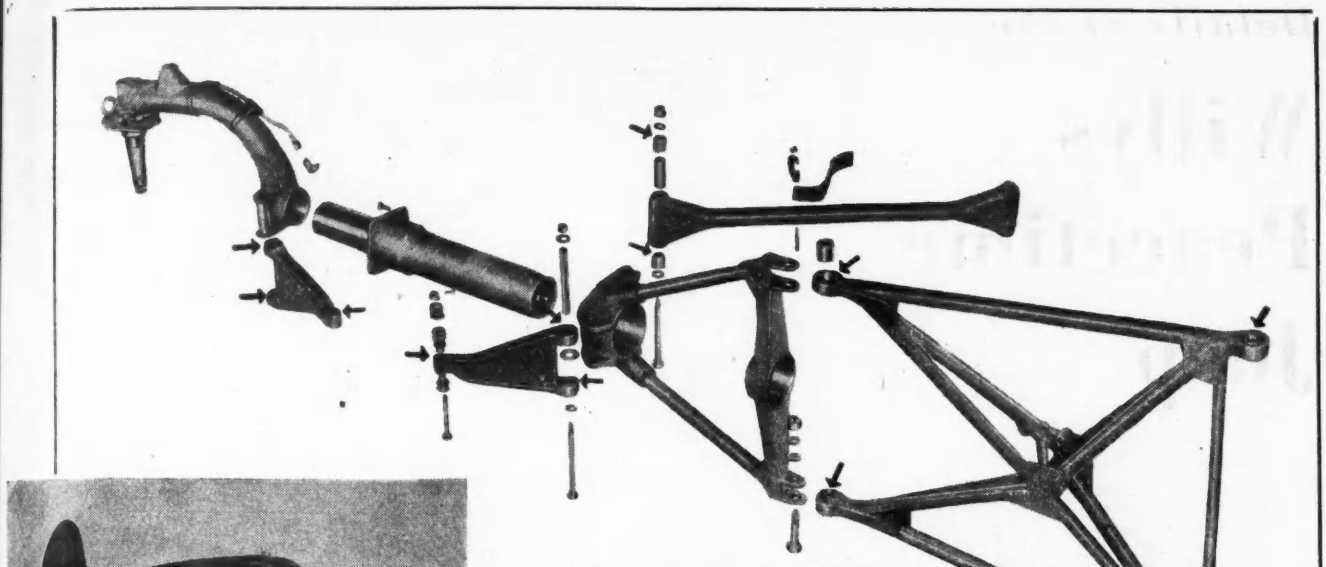
The nut floats in all directions, insuring self-alignment of nuts with the bolt axis. The base is fabricated from high strength ST aluminum and has high resistance to torque and thrust; flanges will not bend and nuts cannot be pushed out. It can be used with high temperature nuts, up to 650 F.

Dow Announces an Improved Polystyrene

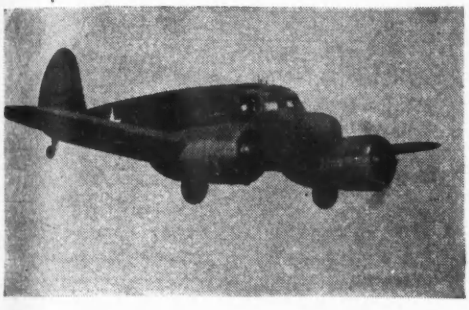
The Dow Chemical Co., Midland, Mich., will replace the present Styron K-27 with a greatly improved polystyrene designated as Styron 411, beginning Sept. 1. The company states that there will be no increase in the price of the improved material.

Among mechanical advantages claimed for Styron 411 are increased weld strength and better machinability. Buffing operations are more easily performed. In trimming, the new material shows reduction in tendency to tear back or produce a laminar condition when cut at the gate. In improving the mold release and eliminating external lubrication, Dow engineers

(*Turn to page* 87, *please*)



Exploded view of knuckle type landing gear used by Cessna C-78 Personnel Transport shows application of Torrington Needle Bearings. Widely used in many types of aircraft, automotive and related equipment, these compact, reliable anti-friction bearings find over fifty applications in this one plane alone.

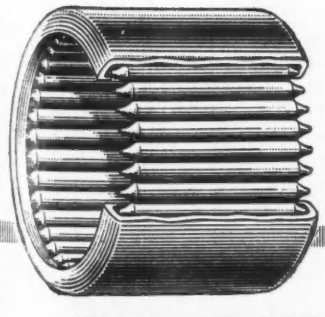


Knuckle Type Landing Gear Operates Reliably on Torrington Needle Bearings

Ability to absorb landing shocks efficiently and reliably is the prime requisite of an airplane's landing gear. That's why, on the knuckle type of landing gear of the Cessna C-78 Personnel Transport (*shown above*), moving elements operate on compact and sturdy Torrington Needle Bearings.

"Their small size and weight," Cessna designers report, "combined with their free, smooth, anti-friction performance *regardless of shock or pressure,* made Torrington Needle Bearings our choice for this application. *And this is but one of over fifty uses of these small, high-capacity bearings in the airplane."*

Are you interested in such reliable anti-friction performance for *your* aircraft, automotive or related equipment? Our new Catalog 32 gives full details on types, sizes and wide range of applications of these compact, efficiently lubricated Needle Bearings. May we send you a copy today?



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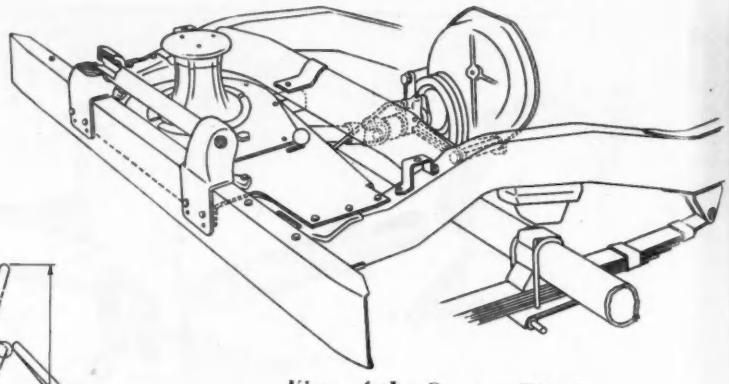
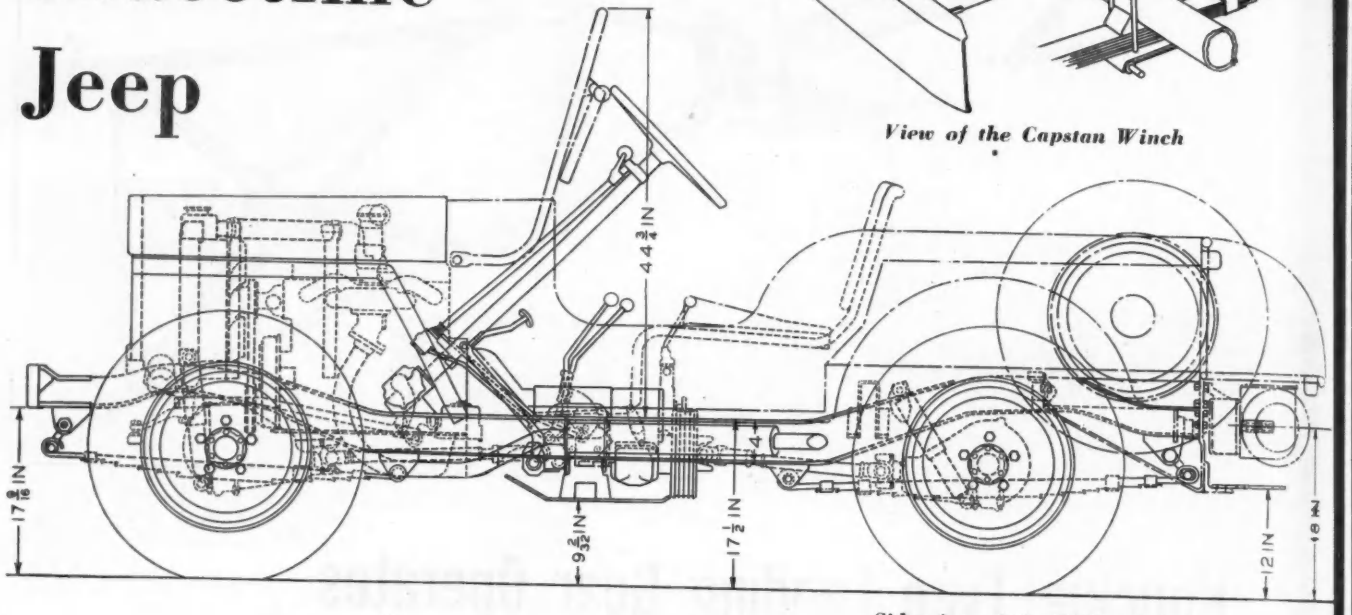
TORRINGTON NEEDLE BEARINGS

Details of the

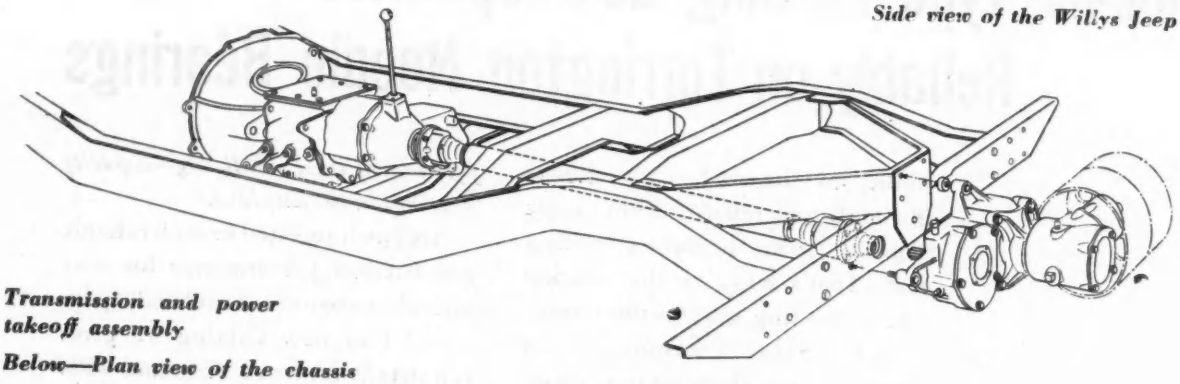
Willys Peacetime Jeep



View of the Capstan Winch

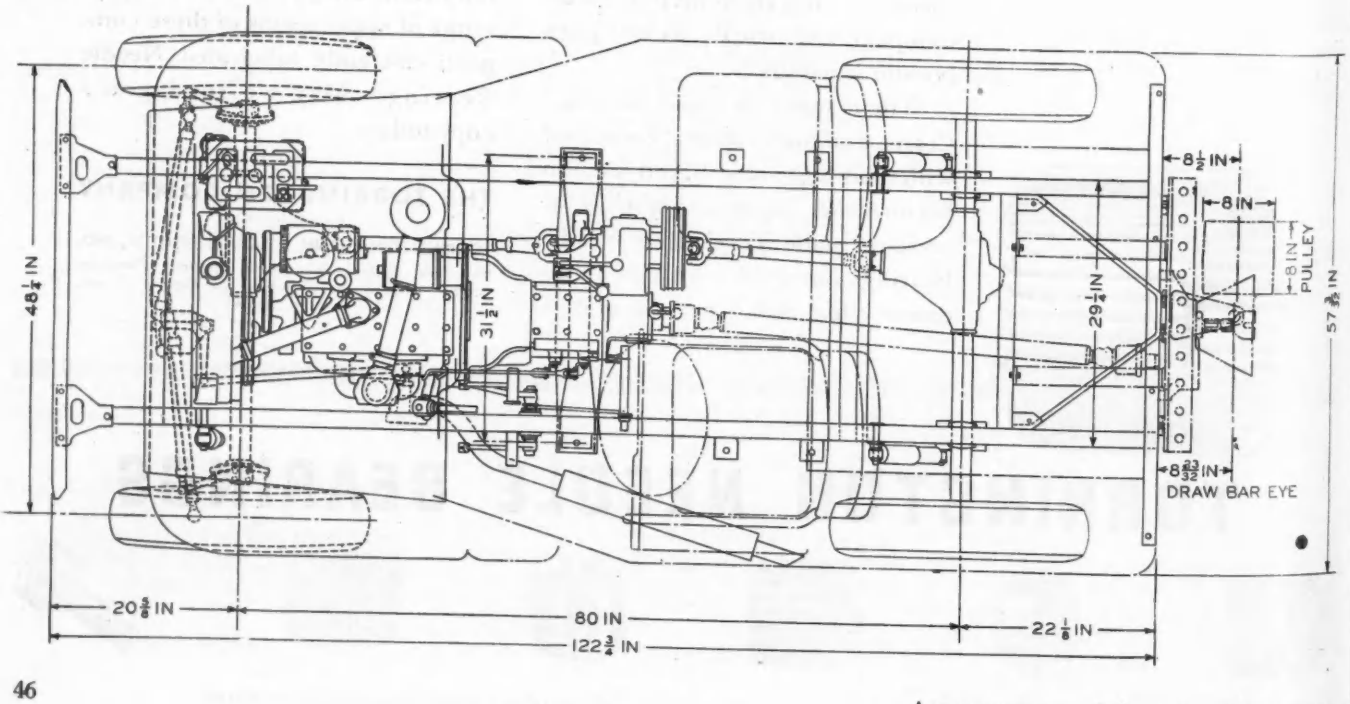


Side view of the Willys Jeep



Transmission and power takeoff assembly

Below—Plan view of the chassis



(Advertisement)

The CONE AUTOMATIC MACHINE COMPANY sees many GOOD THINGS AHEAD

It is reported that . . . . . .

A mathematical method for exactly determining the shapes of cams has been worked out by two university professors. *Carver & Quinn, Cornell Univ.*

get ready with CONE for tomorrow

Reverse-cycle heating is in actual use. In principle it consists in taking heat from the outside air (even the coldest air has some heat in it) and concentrating it for use indoors. Even better results may be had by using the heat in ground water from deep artesian wells. Where electricity is cheap, it seems to be a practical method as the only cost is the operation of the pump. *Science Digest.*

get ready with CONE for tomorrow

Plastic records used in a new electronic dictation machine are claimed to be so thin and flexible that they may be folded and mailed. *Sound Scriber Corp.*

get ready with CONE for tomorrow

A new method of spraying airplane "dope" uses heat instead of thinner to liquefy the material. *Sherwin-Williams.*

get ready with CONE for tomorrow

One city is investigating the possibility of an 8-mile subway in which passengers would be carried by an endless conveyor belt. *Detroit.*

get ready with CONE for tomorrow

Water, nearly equivalent to distilled water in purity, may now be produced by passing through filters made of synthetic resins. After continued use, the filters may be renewed by flushing. *Resinous Products Chemical Co., Philadelphia.*

get ready with CONE for tomorrow

One of our airlines plans to inspect its planes by X-ray at 750 hour intervals in order to reveal hidden weakness or failure. A portable X-ray machine will be used and 4 to 5 days will be required to take the 352 shots believed to be necessary. *Air Transport.*

One factory, serving 18,000 meals per day, believes that the day of the lunch pail is over. *Sperry Gyroscope.*

get ready with CONE for tomorrow

One of the largest printing press manufacturers announces a postwar press to produce newspapers with 4 colors on all pages. *R. Hoe & Co., Inc.*

get ready with CONE for tomorrow

High-nickel alloy tubes can now be made in sizes up to 11 in. diameter by extrusion. *International Nickel.*

get ready with CONE for tomorrow

A new high speed motion picture camera takes 8,000 pictures per second. When projected at normal speed, the result is a slowdown of 500 to 1. *Bell Telephone Laboratories.*

Chemists expect that fish may become more important as a source of industrial chemicals than as food. Already substances have been isolated that appear to be useful in paints, inks, lacquers, plastics, photographic papers, adhesives and medicines. *Business Week.*

get ready with CONE for tomorrow

A Cuban inventor has received a patent for the production of alcohol by continuous flow. *Patent 2,371,208.*

get ready with CONE for tomorrow

A method is reported for making synthetically optical crystals far larger than any produced by nature. *Polaroid Corporation.*

get ready with CONE for tomorrow

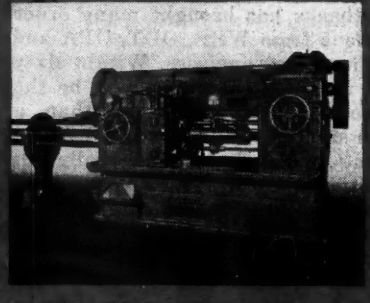
Permission has been granted to build a station for color television experiments. *Zenith Radio.*

get ready with CONE for tomorrow

A large manufacturer of railroad cars expects that 27,000 of the country's 30,000 railway passenger cars will have to be replaced after the war. *Pullman-Standard.*

Greater ACCURACY —Less TIME

The history of modern production is a story of greater accuracy in less time. The coming of peace will emphasize this trend. Owners of 6-spindle Conomatics, that produce parts like these in seconds, will be ready for the new competition.



CONE

AUTOMATIC MACHINE CO., INC. ★ WINDSOR, VERMONT, U. S. A.

21

Industry Plans Expansion for Production of Peacetime Products

Materials Situation Improves as Many Controls by WLB, ODT and other Emergency Agencies are Dropped

To appreciate the staggering blow dealt the national production machine, it is only necessary to note that within one week after peace, cancellations had hit $31.5 billion and were still climbing. Although this amounts to a cut of about 70 per cent overall initially, the affect on many individual programs was 90 to 100 per cent. The automobile industry, which had been heavily engaged in war work, probably was hit the hardest of any, with the possible exception of aircraft. It now is faced with the tremendous job of unscrambling its facilities in the shortest possible time in order to get rolling on peacetime production. In addition to restoring original assembly lines, a tremendous new construction program will be carried out before the expansion contemplated is completed. This already is underway, aided by relaxing of government restrictions on industrial projects which are destined to provide employment.

Abandonment of the controlled materials plan with the exception of one civilian and two military ratings has brightened the outlook for materials considerably. Steel is improving daily and large cancellations of government orders for textiles should relieve the shortage of upholstery and trim cloth soon. Still on the critical list are tin, crude rubber, and chromic acid. However, since WPB has retained power to grant priority assistance to break reconversion bottlenecks, it is safe to assume that in the event any of these short materials threatens to stall car production, WPB will take action to provide the needed items.

V-J Day and its accompanying military cutbacks has brought many order revocations from WPB, ODT, OPA and other emergency agencies. Within sixty days it is hoped that OPA will be the only war agency with more than a skeleton staff. WPB will have removed all production ceilings, practically all distribution controls, and most materials orders, except those covering tin, crude rubber, paper products, lumber, clay products, cotton textiles, and leather.

Passenger car tire rationing is to be lifted within 2 or 3 months and truck tire rationing within 3 or 4 months. Used truck tires have already been removed from rationing, and OPA has restored previously non-eligible truck operators to the eligibility list for new tires. Ration boards have been instructed to give precedence to essential civilian needs for truck tires. Army tire contracts have been cut 100 per cent. Rationing of all farm-implement and industrial type tires has been ended. Large-truck-tire inventories on June 30 were only 131,000 units, slightly more than two weeks' quota. Small truck tires also are seriously short in two of the 10-ply categories, 7.00 and 7.50. About 8 to 10 million passenger car tires and 5 million truck tires will be produced in the fourth quarter. Truck rationing will be lifted within 2 or 3 months. ODT has received 88 per cent of its fourth quarter steel requests assuring expanded truck production.

Tin and crude rubber will remain tight until these materials can be obtained in volume for the Far East. Paper products will ease by the end of the year. The situation in regard to lumber, clay products and cotton textiles will ease when adequate manpower returns to these industries and normal distribution channels are filled, a matter of a few months at most.

Inventory limitations will be maintained for those items on which dis-

(*Turn to page* 54, *please*)

Three-Point Formula Established for Determining New Car Prices

General Increase in Prices Above 1942 Level Unlikely According to OPA Administrator Bowles

OPA Administrator Chester Bowles on August 27 announced the suspension of price control on automotive parts sold as original equipment and the establishment of a three-point formula for the use of automobile manufacturers in determining the ceiling factory prices of their new passenger cars. Under OPA's reconversion pricing formula, new car factory prices are to be computed on the basis of the costs of 1941 models, to which are to be added increases in basic wage rate schedules, plus a normal peacetime margin of profit. The profit factor will be either the manufacturer's own 1936-39 margin or one-half the industry average for that period, which ever is the higher.

The OPA price ruling was given to the automobile manufacturers at conferences held in Detroit during the week of August 20, and despite the ending of world hostilities, they found themselves still enmeshed in bureaucratic red tape on the manufacture of civilian goods. As AUTOMOTIVE AND AVIATION INDUSTRIES goes to press, OPA reported the pricing formula was not ready for public announcement, as decisions were still pending on some details, but in Detroit the pricing procedure was found to be complicated and the outcome uncertain. In Washington OPA Administrator Bowles stated that it is unlikely that there will be any general increase in the factory level of new car prices over 1942 prices. He continued:

"However, OPA's reconversion formula is to be applied by each manufacturer on the basis of his own experience. If any ceiling increases are called for by our pricing rules, of course they will be granted.

"If I should be wrong in my present expectation and there should be a general increase in factory prices, our next step would be to see whether absorption of all or part of the increases could reasonably be required of automobile dealers. The courts have declared that it is obligatory for OPA to do this. President Truman's executive order of August 18 emphasized this duty.

"We are already conducting a study of automobile dealer margin, and no action would, of course, be taken until the facts are in and the dealer groups have been consulted.

"It is a fair assumption that the pub-

(*Turn to page* 54, *please*)

Bottlenecks in Supply of Strip and Sheet Steel Less Formidable

Improvement in the Supply of Skilled Steel Mill Labor Expected as a Result of the Number of Returning Veterans

By W. C. HIRSCH

The aftermath of the two-day peace holiday, which engulfed the steel industry as it did all other productive activities, has given way to more orderly conditions. There still are many uncertainties to overcome, stemming principally from the inability to gage the extent to which consumers can absorb the output of mills in the immediately following months. That the overall program of top-rate production remains unaltered is implied by word from Duluth that the goal of the movement of iron ore through the Great Lakes remains at 85,000,000 gross tons for the 1945 season and that the War Production Board has ordered no reduction in this tonnage. Nearly all of the blast furnaces that were placed on reduced wind or banked when operating crews began to celebrate, have come back into operation, and there has been a decided lessening of absentees in all mill departments. Slow, but gradual improvement in the supply of skilled steel mill labor is confidently expected as a result of the increase in the number of returning veterans.

Bottlenecks in sheets and strip begin to look less formidable, although still unrelieved in spots. Some steel producers have built up sizable backlogs of tentative orders which they booked subject to whatever delays military priorities might make necessary. These commitments are counted upon to cushion many of the difficulties of the transition period, and in a few cases buyers have already been asked to furnish specifications.

Hardest hit by the cessation of hostilities were the makers of shell steel, but the almost abrupt ending of production through the termination of contracts was quickly followed by the absorption of workers in the production of other descriptions of steel.

Perhaps the most difficult of all problems connected with the ending of the war is timing of the lifting of price controls. Ending of the allotment procedure on steel, copper, and aluminum by WPB has caused a certain amount of confusion, some misinterpeting it as spelling the end of price ceilings, which definitely have not been done away with. So long as these are in force, there is little justification for what the newspapers refer to as the re-establishment of a "free market."

According to Bertrand Fox, director of the Program and Statistics Bureau of WPB, military cutbacks will approximate 90 per cent of what was expected in the fourth quarter. The military will probably take 4 per cent of the available supply. Mr. Fox estimates fourth quarter sheet steel demand as probably in the neighborhood of 1,000,000 tons.

A 90 per cent reduction in the armed forces' copper needs is forecast as the result of the termination of hostilities and with domestic crude production at around 75,000 tons a month, the outstanding problem is the building up of demand, so that South American and African producers may continue to share in the United States market.

It is learned that the Malayan Chamber of Mines has chosen a panel of engineers who, with their Dutch colleagues, will proceed with as little delay as possible to make a comprehensive report on the post-war condition of the Malayan and Netherlands East Indies tin properties. They will ascertain how much tin is overground and available for marketing as well as how many of the dredges and gravel pumps at the tin mines must be replaced to make full production possible.

Negotiation for Willow Run Lease Confirmed

Negotiations are underway between Kaiser-Frazer Corp., newly formed $5 million automobile company owned jointly by Graham-Paige Motors Corp. and Henry J. Kaiser interests, and the R.F.C. for a five-year lease of the Willow Run Bomber Plant, now idle and declared surplus.

A. J. Fushman, R.F.C. regional manager at Detroit, stated that the offer had been made for the main manufacturing plant comprising approximately 2.6 million sq ft of floor space, but did not include other facilities such as the airplane hanger and landing field. Before the deal can be concluded, however, it must first be approved by the Surplus Property Board. The plant still is open for bids for sale or lease from any other company, although it is understood that none has been made.

If the corporation obtains Willow Run, initial production of both the Kaiser and Frazer cars will begin there, according to Jos. W. Frazer, president and general manager. In addition, part of the plant will be used for manufacture of the Frazer tractor and the Rototiller farm tillage implement. He added that plans for production of automobiles on the West Coast are well underway and that additional plant facilities are being sought there.

(*Turn to page 76, please*)

PERSONALS

Recent Appointments Among Automotive and Aviation Manufacturers:

Bendix Aviation Corp., Zenith Carburetor Div., **F. E. Williams,** General Sales Mgr., and **C. E. Sexauer,** Service Mgr.

General Motors Corp., Buick Div., **John G. Davies,** Mgr., Buick New York Zone.

Hudson Motor Car Co., **Edward J. Beguhn,** Sales Mgr., Midwest Div., with headquarters in Detroit.

Hupp Motor Car Corp., **Fred Hoelzel,** Product and Sales Engineer.

Reo Motors, Inc., **Robert D. Hilty,** Asst. Sales Mgr.

Curtiss - Wright Corp., Airplane Div., **Gregory J. Brandewiede,** Director of Sales. **Charles H. Augspurger,** Director of Public Relations. **Gladding B. Coit,** elected Treasurer of the Corp.

Packard Motor Car Co., **W. E. Osband,** Mgr. Sales Division.

The White Motor Co., **John A. Tenborg,** Chicago Branch Manager; **Stanley F. DeVore,** Manager, St. Louis Branch, and **J. D. Courtright,** Manager, Kansas City Branch.

Ford Motor Co., **Harold K. Turner,** Mgr. Dearborn Branch. **John Weld,** Public Relations Representative for Eastern Region, with headquarters in New York City.

Brown Instrument Co., **Henry F. Dever,** elected President.

Fairchild Engine and Airplane Corp., Ranger Aircraft Engines Div., **Ernest G. Whitney,** Asst. Chief Engineer.

DoALL Co., **E. R. Haan,** Director of Advertising.

Crosley Corp., **Irving B. Babcock,** elected President.

Rochester Ropes, Inc., **Col. Joseph P. Woodlock,** Executive Vice-Pres.

Wickwire Spencer Metallurgical Corp., **A. G. Bussmann** and **L. D. Granger,** elected Vice-Presidents.

The Niagara Machine and Tool Works, **Franklin A. Reed,** Sales Mgr.

Detroit Seamless Steel Tubes Co., **J. J. Kraus,** Sales Vice-President.

The Watson-Stillman Co., **James S. Wilson,** Mgr. of Plastics Equipment Sales.

The Parker Appliance Co., **S. B. Taylor,** President.

Minneapolis - Honeywell Regulator Co., Aeronautical Div., **Russell H. Whempner,** Sales Mgr.

Republic Steel Corp., **N. J. Clarke,** Senior Vice-Pres., and **J. M. Schlendorf,** Vice-Pres. in chg. of Sales.

Graham-Paige Motors Corp., **O. C. Tharp,** Mgr., Kansas City Zone.

Clark Equipment Co., **E. M. Schultheis,** Mgr., Automotive Sales; **Leo. A. Bixby,** Mgr. of Engineering for Automobile Div. **Major Charles H. Warner,** Mgr., Washington Office.

General Electric Co., **D. C. McCune,** Western District Representative, with headquarters in Dallas.

North American Philips Co., Inc., **Louis J. Chatten,** Vice-Pres. and Gen. Commercial Mgr.

C. M. Hall Lamp Co., **Charles W. Anklam,** Executive Asst. to the President.

American Foundry Equipment Co., **Morton I. Dorfan,** Mgr., Dust and Fume Engineering Div.

Westinghouse Electric Co., Lamp Div., **Henry B. Ahlers,** Asst. on R. C. Stuart's staff; **Dr. Albert Brann,** Mgr. of Division's specifications and standards dept.; **Paul B. Tully,** Asst. Mgr., Lamp Mfg.

Peerless Machine Co., **James E. Thoms,** Vice-Pres. in Chg. of Sales and Gen. Administration.

The Gray-Mills Co., **A. J. Zaber,** Works Mgr.

Evans Products Co., Sky Products Div., **Robert A. Terry,** Sales Mgr.

Casco Products Corp., **Jack Schenberg,** Secretary.

Lear, Inc., **John A. Allwood, Jr.,** President and General Manager, elected a member of the Board of Directors.

Standard Oil Co. of Indiana, **L. A. Henry,** Mgr. Aviation Dept., Chicago general sales office promotion dept.

PUBLICATIONS

A new 12-page booklet entitled **Faster, Better Finishing of Metal, Plastic and Glass,** which describes the 3-M Wetordry Method of precision grinding and finishing at high speeds, has been published by the Minnesota Mining and Mfg. Co. A feature of the booklet is the numerous illustrations showing actual industrial applications of the 3-M Wetordry Method.*

The Electronic Corp. of America has announced the publication of a booklet, **The Amazing Electron.** Illustrated in cartoon technique, and simply written, the booklet is intended to bring within the grasp of everyone the basic facts about electronics.*

The current (July) issue of Bakelite Review, published by the Bakelite Corp., contains an interesting article on **superchargers for pilots.***

Alloy Rods Co. has published a new catalog illustrating and describing several types of **stainless arc welding electrodes** manufactured by the company, together with an electrode analysis and color chart, recommended current ranges for welding and American Iron and Steel Institute type numbers, applicable to these products.*

Udylite Corp. has issued two new circulars as follows: 1) Udylite **Ball Anodes** and Udylite **Cathode rod agitators.***

W. O. Barnes Co., Inc., has a new 48-page book, **Handbook of Metal Sawing,** a treatise on metal sawing in the industry. It contains several pages of general recommendations on the use of hand and power hack saws, together with instructions on the operation and adjustment of metal cutting band saws.*

The Carpenter Steel Co. has published a new 24-page booklet on **tool steel drill rods.** It gives useful information on the selection of tool steel drill rod, heat treatment and complete tables of standard sizes.*

A. P. de Sanno & Son, Inc., has issued a new **Por-Os-Way Segment folder.** Job recommendations for Por-Os-Way segments and a table of standard chuck sizes are included.*

An attractive 24-page booklet, **Jeep Planning,** has been published by Willys-Overland Motors, Inc. The booklet is done in four colors and is well illustrated with photographs showing the new Universal Jeep performing a wide variety of agricultural and industrial chores.*

Pratt & Whitney, Div. of Niles-Bement-Pond Co., has issued a **Condensed Catalog** covering a complete list of Pratt & Whitney products—machine tools, Keller Machines, Kellerflex, small tools and also its agency sales line. It is a 72-page book of condensed information, illustrations and specifications.*

Republic Drill and Tool Co. has issued an illustrated 40-page booklet about **Shankless roll-forged drills.** The book describes how Shankless drills are made and explains how their advantages are effected.*

Pennsylvania Salt Mfg. Co. has announced a new pocket-size booklet, **Pennsalt Industrial Chemicals and Specialties.** The descriptive booklet lists the industrial chemicals and specialties manufactured by Penn Salt under the Sales Division controlling them.*

* Obtainable by subscribers within the United States through Editorial Dept., AUTOMOTIVE *and* AVIATION INDUSTRIES. In making requests for any of these publications, be sure to give date of the issue in which the announcement appeared, your name and address, company connection and title.

ACWP Activities Continue

Although the charter under which the Automotive Council for War Production was founded calls for its liquidation immediately after the end of the war, many of its activities involving reconversion problems will be carried on through other established organizations. Following a recent meeting of the directors, certain committees have been put on a stand-by basis and many functions have been transferred to Automobile Manufacturers Assn., Automotive and Aviation Parts Manufacturers Assn. and other members of the Council. Dues also have been reduced from eight cents a thousand gross sales to two cents. It is expected, however, that with ultimate dissolution of the Council, most of the personnel will remain with AMA.

Foundrymen Plan Convention and Exhibit in 1946

The American Foundrymen's Association plans to stage its 50th Anniversary Foundry Congress and Foundry Show in the Cleveland Auditorium, Cleveland, next May.

Coupled with announcement of the 1946 event is the intention to stage the meeting as an International Foundry Congress, with attendance from foundrymen of England, France, Belgium, Russia, Mexico, South America, South Africa, Australia, China and other countries. If held, this will be the third International Foundry Congress to which the American Foundrymen's Association has played host—the first being held in Detroit in 1926, the second in Philadelphia in 1934. The International aspects of the 1942 convention in Cleveland were canceled due to war conditions.

Teleoptic Acquires "Fog King" and "Road King"

The Teleoptic Co., Racine, Wis., has purchased from Winzeler Mfg. & Tool Co. of Chicago its Driving Light Division, makers of "Fog King" and "Road King" driving lights. Teleoptic has acquired all rights to these trade names as well as the inventory of lights and material.

In future the "Fog King" and "Road King" lights will be manufactured at Teleoptic's Mound Ave. plant in Racine, that both sealed beam and reflector types will be distributed to the automotive trade and that a new improved sealed beam driving light will be added to the line.

Carpenter Steel Opens New Warehouse

The Carpenter Steel Co. of Reading, Pa., announces the opening of a new warehouse and office located at 790 Greenwich Street, New York, N. Y. The New York warehouse will be under the supervision of R. P. Evans.

Ford-Ferguson Tractor Production Moved

Production of Ford-Ferguson tractors has been moved from the Ford Rouge plant to the Highland Park works and is rapidly increasing on a virtually unrestricted basis. The moving job, involving transfer of considerably heavy equipment is estimated to have cost nearly $175 million. A small part of production had been going to the armed forces, but with the end of the war, all now will go to domestic users.

Nox-Rust Corp. Changes Name

The Nox-Rust Corp., Chicago, Ill., has changed its name to the Nox-Rust Chemical Corp. The organization is celebrating its 10th anniversary in the manufacture of rustproofing.

Business in Brief

Written by the Guaranty Trust Co., New York, Exclusively for AUTOMOTIVE AND AVIATION INDUSTRIES

Narrow fluctuations in general business activity are currently indicated. *The New York Times* index for the week ended August 4 declined to 139.1 from 140.4 in the preceding week, as against 144.8 a year ago.

Department store sales as reported by the Federal Reserve Board for the week ended August 4 increased substantially—the index for the period standing at 168 per cent. of the 1935-39 average, as compared with 153 in the week before and 137 a year ago. Other comparisons with last year's corresponding figures show gains of 17 per cent for the four weeks ended on that date and 13 per cent for 1945 thus far.

Electric power production declined contra-seasonally in the week ended August 11. The output was 0.5 per cent below the comparable level last year, as against a rise of 0.7 per cent recorded a week earlier.

Railway freight loadings during the week ended August 4 totaled 863,910 cars, 2.5 per cent fewer than for the preceding week and 2.9 per cent less than the corresponding number a year ago.

Crude oil production in the same period averaged 4,922,100 barrels daily, 7,900 barrels less than the preceding weekly figure but 271,450 barrels above the corresponding average in 1944.

Production of soft coal in the week ended July 28 is estimated at 11,930,000 net tons, as against 11,500,000 a week earlier and 12,385,000 tons a year ago. The production thus far in 1945 is 6.7 per cent below the corresponding quantity last year.

Engineering construction contracts awarded during the week ended August 9, according to *Engineering News-Record,* totaled $30,184,000, as against $76,351,000 for the preceding week, a two-year peak, and $39,507,000 in the comparable period last year. For 1945 to date, the contract total is 3 per cent above the corresponding amount in 1944.

The *Journal of Commerce* weekly index of wholesale commodity prices as of August 11 rose to 112.0 per cent of the 1927-29 average, a new peak, as against 111.6 a week earlier and 108.0 a year ago.

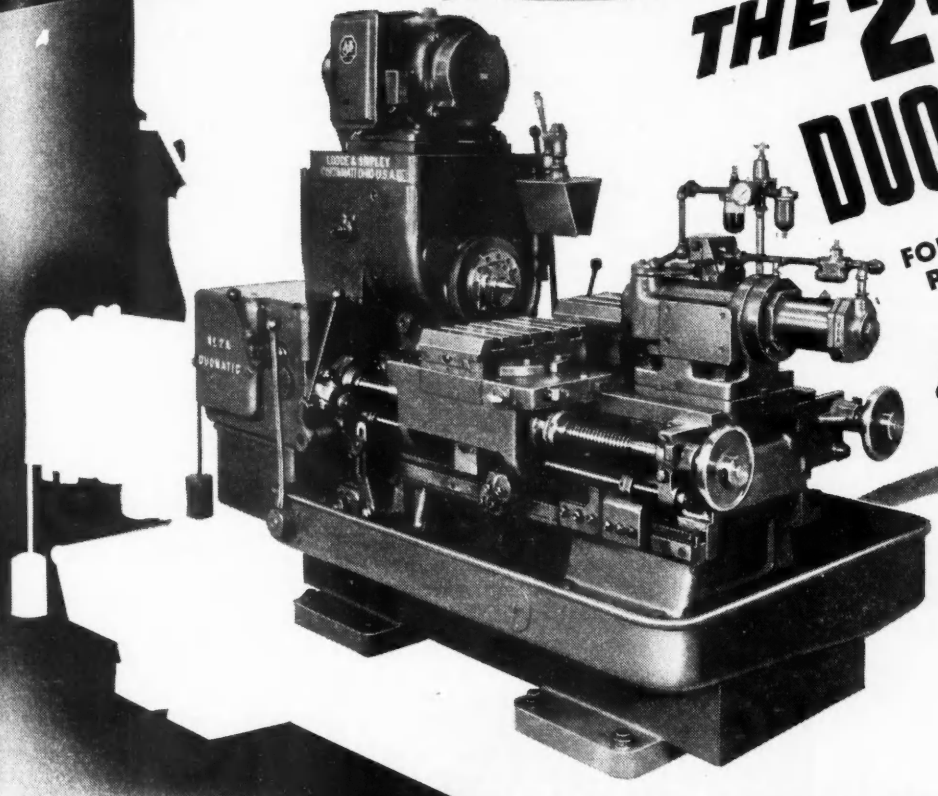
Member banks reserves declined $28,000,000 during the week ended August 8, reflecting an increase of $42,000,000 in total Reserve bank credit, a reduction of $140,000,000 in Treasury deposits with the Reserve banks and other changes. Excess reserves were unchanged at an estimated total of $1,140,000,000. During the same week, earning assets of reporting member banks declined $944,000,000, including a reduction of $12,000,000 in commercial, industrial and agricultural loans. Total loans and investments of these banks in 101 cities stand $6,528,000,000, or 11.5 per cent, above the corresponding amount last year.

NEWEST ADDITION TO THE LODGE & SHIPLEY LINE

THE 2-A DUOMATIC

FOR FASTER, BETTER PRODUCTION OF

SMALL JOBS



FULLY AUTOMATIC
with all the features of the bigger 3-A

Now, whether your jobs are large or small DO IT WITH A DUOMATIC! The 3A Duomatic—a full automatic lathe—has long proved its ability to cut time, increase output on a wide range of work. Now, Lodge & Shipley introduces another automatic lathe—the new 2A.

The 2A Duomatic is designed for smaller jobs, yet it retains all the features of the big, powerful 3A. Operations are entirely mechanical. Dual tool slides and carriages permit any combination of turning and facing cycles—front and rear, simultaneously or independently. As on the 3A, front or rear cross slides swivel to any angle for a wide variety of facing operations. No cams are required to change cycles. Easy adjustments permit fast, accurate handling of large or small runs.

Like two lathes in one, this new automatic may easily replace several of your older, work-worn machines. It's another example of Lodge & Shipley leadership in lathe design—made possible through 52 years of specialized lathe experience. For details on the new 2A Duomatic write on your company letterhead.

THE LODGE & SHIPLEY MACHINE TOOL CO.

CINCINNATI, OHIO, U. S. A.

MACHINE TOOL DIVISION • SPECIAL PRODUCTS DIVISION

3055 COLERAIN AVENUE 800 EVANS STREET

L & S LATHES

Industry Plans Expansion

(*Continued from page* 48)

tribution controls are to be retained. Special priority instruments used in the distribution field, such as Forms WPB-547 and WPB-1319, will be discontinued by the end of September. PR 19, which provides special assistance for farm supplies, will likewise be revoked, along with the various blanket maintenance, repair and operating supplies orders. Distributors' inventory orders L-63 and L-219 are now being resurveyed to determine their effectiveness.

With millions of workers being released from war plants and the armed services, the help situation should ease considerably. WMC has dropped all manpower controls, including the mandatory 48-hour week. Only the administrative functions of USES are being retained by WMC to assure placement facilities for workers seeking employment.

FEA will continue some export licenses and import controls until a more normal balance of trade is achieved and the danger of inflation is past.

ODT has revoked the order which required all commercial operators to obtain a certificate of necessity to operate trucks, buses, or taxicabs. New commercial motor vehicle service may be inaugurated or extended without ODT approval.

Wage or salary increases may be made, through collective bargaining or voluntary action without the necessity of obtaining prior approval, provided that such increases will not be used as a basis for seeking increases in price ceilings or resisting otherwise justifiable price ceiling reductions.

New Car Prices

(*Continued from page* 48)

lic is unlikely to pay more for most 1945 model cars than the present ceilings on 1942 models—minus the special charges that were allowed beginning early in 1942 to cover added costs to dealers from rationing.

"If, however, manufacturers make any substantial changes from their 1942 models which result in net increases or decreases in costs, OPA will provide for increases or decreases in ceilings. Any increases caused by such changes naturally need not be absorbed by dealers.

"Since manufacturers are now working out the application of OPA's pricing formula to their 1945 models for submission to OPA, it is obviously impossible to state at this time what changes in present ceilings, if any, may result.

"Any rumors that 1945 ceilings for any make and model are now definitely known are therefore untrue.

"If the price computed according to the OPA formula is higher than the manufacturer's 1941 model price, this will become his new ceiling price. If it is below his 1942 price, that 1942 price will stand. Provision will be made in either case for substantial model changes resulting in net cost changes.

"It must be remembered that the automobile industry increased the price of its 1942 models by from 10 to 19 per cent over the prices of the 1941 models. Since the adjustment for cost increases now authorized by OPA's formula are to be applied to a 1941 model base, these 1942 model price increases will serve to cushion the effect of these cost adjustments."

Buffalo Bolt Co. Expands

Buffalo Bolt Co., North Tonawanda, N. Y. has acquired for cash and stock of the entire capitalization of the Eclipse Lawn Mower Co. of Prophetstown, Ill., manufacturers of hand and power driven lawn mowers.

The Eclipse Lawn Mower Co. will be operated as a wholely owned subsidiary of the Buffalo Bolt Co. The company will continue under the same management as in the past and will utilize the same channels of distribution that it has used during the past forty years.

Awards

Names of winners of Army-Navy "E" awards in or allied with the automotive and aviation industries announced since the July 1 issue of AUTOMOTIVE *and* AVIATION INDUSTRIES went to press:

AMERICAN CHAIN & CABLE CO., INC., Electric Welding Plt. & Malleable Foundry, York, Pa.
ANACONDA WIRE & CABLE CO., Anderson, Indiana Mill, Anderson, Ind.
ANDERSON AIRCRAFT, INC., New York, N. Y.
BENDIX AVIATION CORP., Marshall Eclipse Division, Green Island, Troy, N. Y.
THE BENWOOD LINZE CO. & THE B-L ELECTRIC MANUFACTURING CO., St. Louis, Mo.
BRIGHT STAR BATTERY CO., Clifton, N. J.
CHASE BRASS AND COPPER CO., INC., Cleveland Mill, Euclid, Ohio.
CHASE BRASS AND COPPER CO., INC., Euclid Case Plant, Euclid, Ohio.
THE CLEVELAND CAP SCREW CO., Cleveland, Ohio.
COLUMBIA AIRCRAFT PRODUCTS, INC., Somerville, N. J.
CONSOLIDATED VULTEE AIRCRAFT CORP., Tucson, Ariz.
THE CUYAHOGA SPRING CO., Cleveland, Ohio.
DAYBROOK HYDRAULIC CORP., Bowling Green, Ohio.
DE KALB COMMERCIAL BODY CORP., DeKalb, Ill.
FANSTEEL METALLURGICAL CORP., Vascoloy-Ramet Corp., Waukegan, Ill.
GENERAL MOTORS CORP., Pontiac Motors Division, Plant 14, Pontiac, Mich.
IDEAL CLAMP MANUFACTURING CO., INC., Brooklyn, N. Y.
JOHNSON GAGE CO., Bloomfield, Conn.
KEYSTONE DRAWN STEEL CO., Spring City, Pa.
LINK-BELT SPEEDER CORP., Link-Belt Co., Cedar Rapids, Iowa.
LENK MANUFACTURING CO., Newton, Mass.
NATIONAL FORMETAL CO., Cleveland, Ohio.
NORTH AMERICAN PHILLIPS CO., INC., Dobbs Ferry & Mount Vernon, N. Y.
NORTHROP AIRCRAFT, INCORPORATED, Hawthorne, Cal.
REPUBLIC STEEL CORP., Niles Steel Products Division, Niles, Ohio.
ROCHESTER MANUFACTURING CO., Rochester, N. Y.
STANDARD ELECTRIC TIME CO., Philadelphia, Pa.
TEMPLETON, KENLY & CO., Chicago, Ill.
TRIPLEX SCREW CO., Cleveland, Ohio.
UNITED STATES MAGNESIUM CO., Pleasant Valley, N. Y.
UNITED STATES RUBBER CO., Providence Plant, Providence, R. I.
VULCAN STEEL PRODUCTS CO., Brooklyn, N. Y.
WESTERN ELECTRIC CO., Lincoln Shops, Lincoln, Neb.
WICO ELECTRIC CO., West Springfield, Mass.

★ "E" Star Awards ★

for continuous meritorious services on the production front have been awarded to the following firms:

BAKER BROTHERS, INC., Toledo, Ohio.
BENDIX AVIATION CORP., Bendix Radio Division, Baltimore, Md.
BENDIX AVIATION CORP., Eclipse-Pioneer Division, Teterboro, N. J.
BOWSER, INC., Fort Wayne, Ind.
CONTINENTAL RUBBER WORKS, Erie, Pa.
FANSTEEL METALLURGICAL CORP., Tantalum Defense Corp., North Chicago, Ill.
INDEPENDENT PNEUMATIC TOOL CO., Aurora, Ill.
W. H. NICHOLS AND SONS, INC., Waltham, Mass.
VITA-VAR CORP., Newark, N. J.

GM Purchases Land Near Atlanta, Ga.

C. E. Wilson, president of General Motors, has announced the purchase of a 250-acre tract near Atlanta, Ga., as a possible site for a postwar General Motors assembly plant. The unit would assemble Buick, Oldsmobile, and Pontiac cars. Before the war, G.M. had B-O-P assembly plants only at Southgate, Calif., and Linden, N. J. Previous announcements told of plants for plants at Kansas City and Wilmington, Del., and it also is understood that an additional one may be constructed in Massachusetts.

Goodyear to Open South African Plant

The Goodyear Tire & Rubber Co. announces the establishment of a rubber manufacturing plant in the Union of South Africa. The new plant will be located at Uitenhage, Cape Colony. It will have an initial daily capacity of about one thousand tires. Construction contracts will be awarded soon.

TRACTOR-TRAILER BRAKES

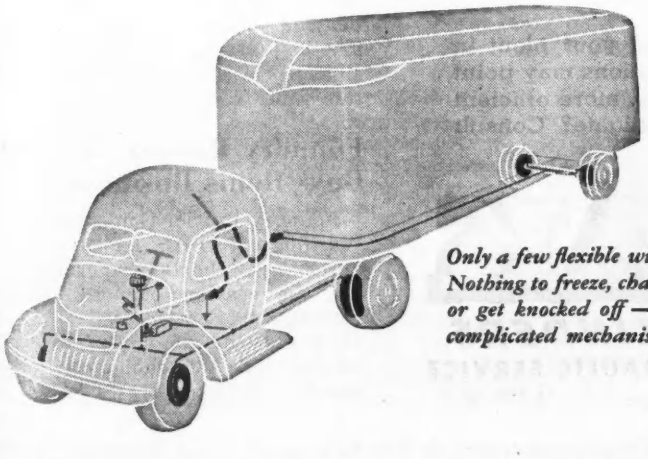
Meet Future Transportation Demands?

Yes...WHEN *BOTH* ARE EQUIPPED WITH WARNER VARI-LOAD ELECTRIC BRAKES

After the war, the demand will be to move heavier loads *faster* over present highways — *and with greater safety.* More powerful engines will pull these heavier loads faster on the level—easier on hills. Just so, more powerful and *better controlled* brakes will be a "must"—to let them *down* the other side *at highest speeds commensurate with safety.*

Warner Vari-Load Electric Brakes have performance-proved their *controlled braking power* on thousands of trailers in essential wartime transport work, and on more thousands of trailing vehicles in the mechanized forces of Allied armies the world over. After the war, Warner Vari-Load Electric Brakes will be available for BOTH *tractors and trailers* — providing *instant and complete control* far greater than any braking method now provides. Controls on the dash will permit pre-setting the *correct braking power* to fit BOTH load and road conditions. With this *absolute control,* all brakes on the tractor and trailer will "come in" at the same instant *but with varying amounts of power.* Thus the tendency to skid or jack-knife will be prevented — heavy tractor-trailer trains can be slowed down or stopped quickly and *safely* — to afford greater protection to drivers and loads, reducing maintenance costs, and avoiding costly lost time due to wrecked equipment.

WARNER ELECTRIC BRAKE MFG. CO., BELOIT, WISCONSIN



Only a few flexible wires. Nothing to freeze, chatter or get knocked off — No complicated mechanisms.

WARNER
ELECTRIC BRAKES

Volume Car Production

(*Continued from page* 17)

full scale production, and the amount of labor trouble.

While sheet steel has been one of the most critical bottlenecks, this situation is expected to clear up shortly, now that most war work is finished. It may take sometime for the mills to convert back to rolling sheet, but most observers believe that the situation will clear up in from 30 to 60 days. Textiles, tin, crude rubber, and chromic acid still are troublesome, but are not expected to stall output of cars. Lifting of controls over steel, copper, and other materials by WPB will be a big help, since the automobile industry now can bid on equal footing with other industries which heretofore had enjoyed rated orders for steel and other scarce materials.

While machinery for the limited quota of 246,000 cars which WPB had authorized for the last half of 1945 was no particular problem, the additional equipment needed for unlimited production now permitted will take a little more time. However, much will b available from surplus stocks and th machine tool industry will be in a pos tion to make swift deliveries now tha war work is finished. It is estimate that by shortly after the first of th year, most of the machinery needed wi be available. Plant clearance must b speeded up considerably and undoub edly will be. Actual contract settlemen can be put off until later, but movin out machinery and surplus material i imperative. Reports indicate that Re construction Finance Corp. procedure are working quite satisfactorily in get ting machines out of the plants in fairly short time.

The outlook on labor is more ominou than any other on factor. The UAW CIO has unlimbered its big guns for a attack on wage rates and already ha made demands on General Motors an Chrysler for pay boosts of 30 per cent and is expected to do the same at For and the other companies. Neither GM nor Chrysler has made a reply, but i is a foregone conclusion that the an swer will be a short and emphatic no Pay issues always are a matter of ne gotiation and the issue will be worked out between the parties in due course but it may mean crippling strikes.

How many cars will be built yet this year is at best anyone's guess, but esti mates vary from a conservative figure of 400,000 to more optimistic predic tions of 700,000. There is no doubt that once it gets going, the industry will pick up speed at an amazing rate and the general opinion prevails that the prewar level of production will be reached shortly after the first of the year. All limitations have been re moved from truck production, also, and one seasoned observer predicts that the combined output of trucks and automobiles this year will be more than one million units.

Immediate Delivery of A-L Parts Is Assured

Customers of The Electric Auto-Lite Co. have been assured that all of the company's manufacturing plants will continue to remain in operation in order to insure immediate delivery of both original and replacement parts.

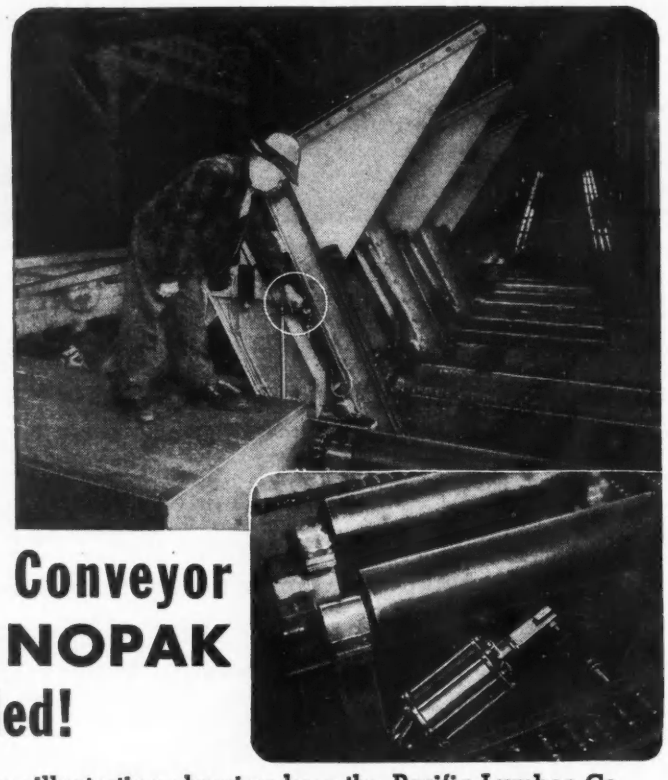
The assurance was given customers by Royce G. Martin, president, in a special announcement that though "a complete inventory is most important, the demands from our civilian customers are so pressing that it will be impossible to close down for that purpose at this time."

Foundry Rubber Compounds Buys Bonis Business

Foundry Rubber Compounds Corp., of Washington, D. C., has announced the purchase of the Bonis permanent mold and die coating business of the St. John X-Ray Service, Inc. These Bonis products will augment the former's regular line of rubber-base pattern, core and mold coatings.

One easy twist of the wrist puts into operation this multi-prong lift at the Pacific Lumber Company's plant.

Dependable NOPAK Air Cylinders do the work . . . replacing manual labor with tireless, instantaneously responsive air power.



Lumber Conveyor Sections NOPAK Controlled!

Here is another illustration showing how the Pacific Lumber Co., Scotia, Calif., employs NOPAK Air Cylinders and NOPAK Valves to control the flow of stock through different mill operations.

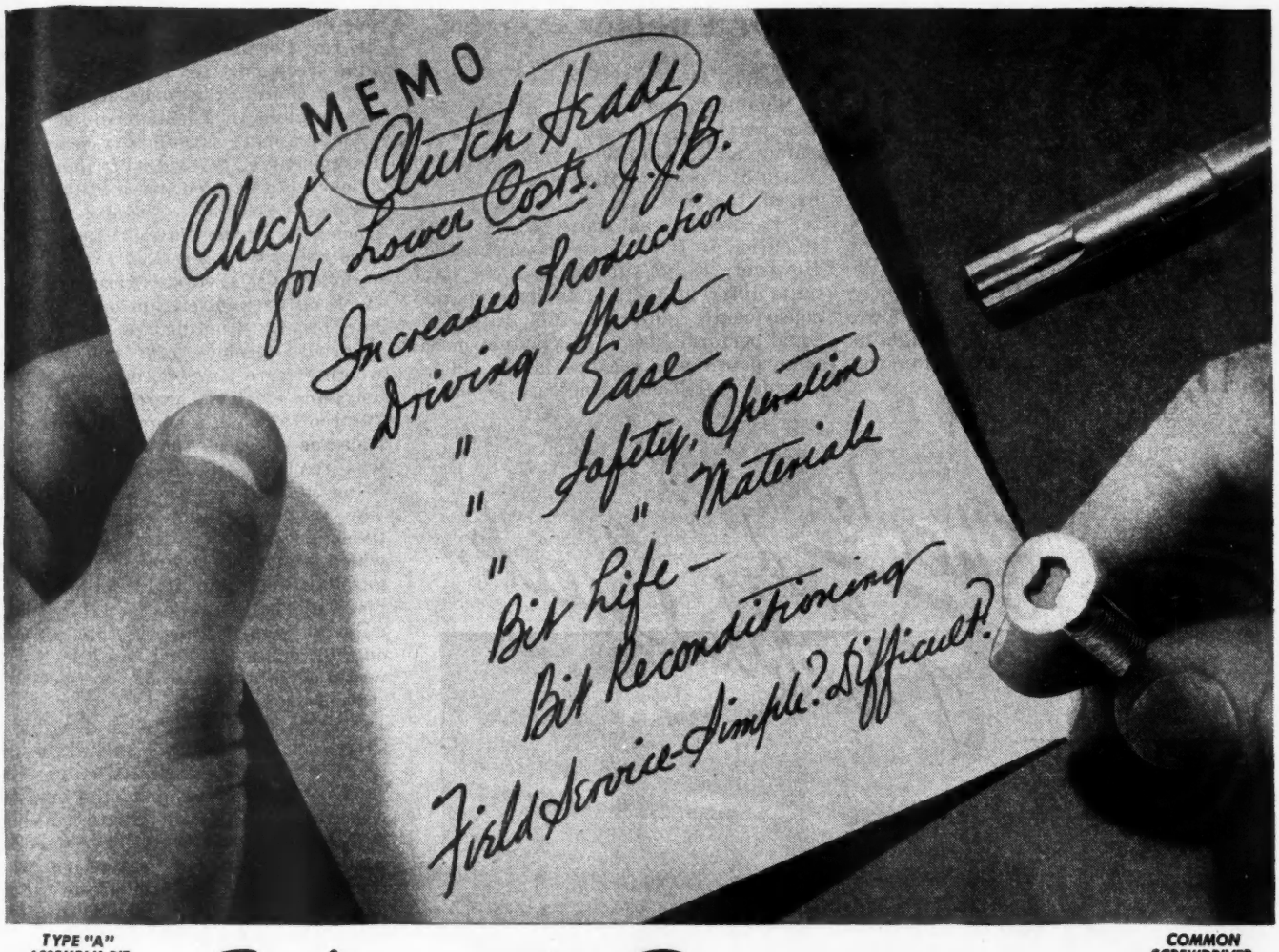
The workman manipulates a NOPAK Hand Operated Valve controlling a group of 10" NOPAK Air Cylinders, which raises the row of lifts at an angle. Gravity then transfers the partially processed lumber to the parallel conveyor at the left.

NOPAK cylinder power is used throughout Pacific's conveyor system to facilitate material handling with minimum manpower. It keeps production moving at a steady pace, eliminates delays and replaces tedious and tiring manual labor.

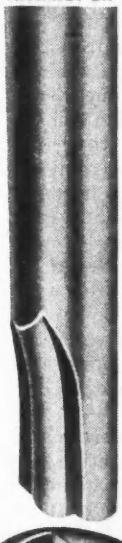
Similar uses of NOPAK Valves and Cylinders in your plant in pushing, pulling, lifting, holding or clamping operations may point the way to higher efficiency, lower operating costs, more efficient handling of cumbersome materials. Why not investigate? Consult your nearest NOPAK representative or write.

GALLAND - HENNING MFG. CO.
2774 South 31st Street
Milwaukee 7, Wisconsin

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE
A 4836-½I-A



TYPE "A" ASSEMBLY BIT



COMMON SCREWDRIVER

Tighten up for Reconversion

The result will show that CLUTCH HEAD Screws have exclusive features and advantages that out-mode all other screws on the market today . . . each a factor that contributes importantly to the *lower final cost* of assembly and servicing.

FOR SPEED . . . Center Pivot entry into the wide roomy Clutch makes straight driving automatic and smooths out slow-down hesitation.

FOR MORE SPEED . . . Driving engagement is all-square. Flat sides of bit contact straight walls of Clutch for effortless, therefore easier and faster, drive home. No ride-out as set up by tapered driving. No fatiguing end pressure to combat. No delay replacing reamed screws and chewed-up heads.

FOR TWO-WAY SAFETY . . . Automatic dead-center entry and positive torque drive (without ride-out) eliminates the slippage hazard . . . protection against injury to manpower and damage to materials.

FOR A NEW LOW IN TOOL COST . . . The rugged Type "A" Bit stands up through long "non-stop" spells, *driving extra thousands of screws* without interruption. Reconditioning to original efficiency requires only a 60-second application of the end surface to a grinding wheel.

SAMPLE SCREWS AND BIT SENT ON REQUEST

FOR BREAKING "BOTTLENECKS" . . A reverse turn of the Type "A" Bit in the Clutch recess forms the Lock-On, uniting screw and bit as a unit for easy one-handed reaching to hard-to-get-at spots. Lock-On is automatically released by normal driving of the screw.

CLUTCH HEAD · SCREWS ·

FOR SIMPLIFIED FIELD SERVICE . . This is the only modern screw basically designed to operate with an ordinary type screwdriver. With a Type "A" driver, the Lock-On feature permits the withdrawing of screws undamaged and held safely for re-use.

UNITED SCREW AND BOLT CORPORATION

CHICAGO 8 CLEVELAND 2 NEW YORK 7

Substitute Motor Fuels

(*Continued from page* 21)

tests on the latter, and those on the single-cylinder engine at a compression ratio (5.11 to 1) suitable for gasoline, agreed in showing that alcohol gives slightly higher power (2 per cent to 5 per cent) than gasoline, with the other blends intermediate. All of the substitute fuels likewise showed a slightly higher thermal efficiency, particularly in the region of lean mixtures, as shown in Fig. 4. No significant change in spark advance was required for the substitute fuels.

Note that the abscissa in Fig. 4 is Btu per hour, instead of the more familiar term, pounds of fuel per hour. When hydrocarbon fuels are being compared, the two terms could be used interchangeably, as there is but little variation in their heats of combustion. However, these substitute fuels have quite different heats of combustion, and consequently different fuel rates for equal performance. For example, maximum power was reached in the single-cylinder tests at a fuel rate of 6.6 lb per hr for gasoline, and at 11.4 lb per hr for 190-proof alcohol. As the engine responds to the heat supplied, rather than to the fuel weight supplied, power plots on a heat basis, as in Fig. 4, offer a more satisfactory comparison. Furthermore, a scale of thermal efficiency can be superposed on such plots, making it possible to see at a glance the efficiencies of the different fuels at mixture ratios of interest.

Some special tests were run on a stock automobile engine on alcohols of low proof. Starting an operation on 70-proof alcohol (29 per cent by weight) were possible, but power, economy, and efficiency were very low. For 70-proof alcohol, a spark advance three times as great as for 200-proof alcohol was required, the respective advances being 50 deg and 17 deg for this engine. The volume of fuel required is relatively enormous. For example, a tank which would run a vehicle 200 miles on gasoline would run it 135 miles on 200-proof alcohol, 60 miles on 120-proof, 40 miles on 90-proof, or less than 25 miles on 70-proof alcohol. Use of such fuels would certainly be a boon to the filling-station business!

Studies of manifold distribution showed that none of the substitute fuels is distributed as well as is gasoline. This is not surprising as the manifold was designed to distribute gasoline. Differences in the volatility, viscosity, surface tension, and heat of vaporization of these fuels contribute to the impaired distribution. Typical distribution patterns for gasoline, ethyl alcohol, and butanol are shown in Fig. 5.

Each of the substitute fuels tested is capable of use at a compression ratio higher than that suitable for gasoline of 70 octane number. Some idea of the performance possible with these fuels in engines designed for their use can be had from Fig. 6, and from Table 2. These data were obtained by operating the single-cylinder engine at a compression ratio such as to give trace knock on the fuel under test, when the spark advance and mixture ratio were adjusted to give maximum power. All of these substitute fuels are capable of giving greater power and efficiency than gasoline, if these fuels are used in engines of suitable design.

Road vapor-lock tests were made only on blends of alcohol with ether or with acetone. For the ether blend which would start at 0F (20 per cent diethyl ether in alcohol), vapor lock occurred at 82F. Starting at 0F would be possible only on pure acetone, which was found to give vapor lock at 70F. The operating temperature limits for these fuels are thus seen to be narrower than for gasoline.

Extensive tests of cylinder wear were carried out in this investigation. Wear was measured by the McKee Wear Gage. By means of this instrument, a diamond-shaped pyramidal indentation 0.0014-in. deep and 0.039-in. long is made in the cylinder wall. As the cylinder wears, the length of the indenta-

(*Turn to page* 62, *please*)

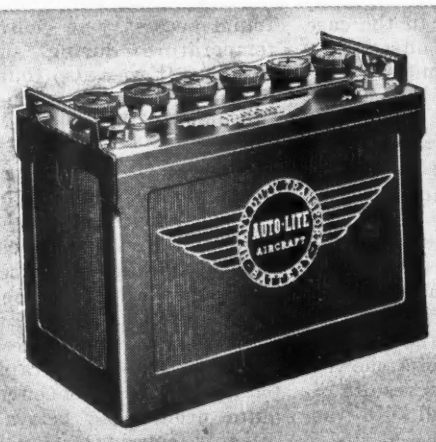
...before this stamp of Precision appears on TURNER Gauges

THE VERY last operation performed on any Turner Gauge before packaging is the application of the Turner Stamp, which you see reproduced above. Prior to this, every Turner Gauge has been checked and double checked in our air conditioned, temperature controlled inspection room. *It is your guarantee that all checking surfaces are accurate to your specifications.*

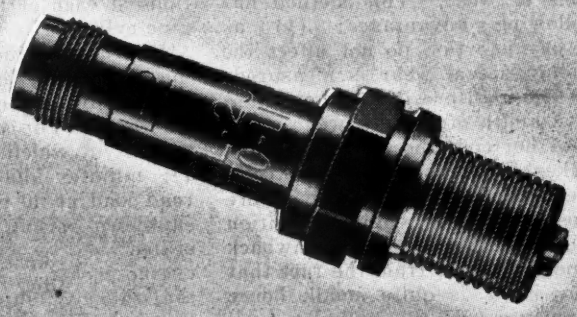
★ *We make cylindrical plug gauges, cylindrical ring gauges, special flush pin gauges, solid type snap gauges, Master Discs, and built-up gauges.* ★

TURNER BROTHERS

TURNER GAUGE GRINDING COMPANY
2625 HILTON ROAD • • FERNDALE 20 MICHIGAN



Available in both 12 volt and 24 volt types. All batteries are equipped with special non-spill vent plugs and assembled in either hard rubber or radio-shielded aluminum containers. The heavy duty battery has a capacity of 105 A.H. at 5 hr. rate; others have capacity of 34 A.H. at the 5 hr. rate.



These spark plugs feature: (1) Direct contact non-inductive resistor located in coolest position in plug; (2) Improved copper cooled center electrode; (3) Deep drawn nickel alloy center electrode tip; (4) High Dielectric strength and superior mechanical properties of "Corundum," Auto-Lite's insulator material.

Auto-Lite

EQUIPMENT FOR AIRCRAFT

On every battlefront of this war where American-built planes are flying you'll find the products of Auto-Lite's 22 great manufacturing plants. Precision-built to meet the most exacting tests, these products, some of which are shown below, are enhancing the Auto-Lite reputation for quality, craftsmanship and dependability.

THE ELECTRIC AUTO-LITE COMPANY

TOLEDO, 1, OHIO • SARNIA, ONTARIO

This dual oil pressure gauge is one of several space and weight saving gauges precision-built by Auto-Lite. It records oil pressure from two engines on same dial, has easy readability and high degree of accuracy. Auto-Lite builds gauges and thermometers to Army-Navy Air Service specifications.

High output, light weight Auto-Lite aircraft generators have compensating windings resulting in long brush life—improved commutation and a remarkable ability to carry over loads. These generators are direct engine driven and designed to deliver 140 amperes at 28.5 volts at 2275 to 4500 r.p.m.

AUTO-LITE

TUNE IN "EVERYTHING FOR THE BOYS" STARRING DICK HAYMES—EVERY TUESDAY NIGHT—NBC NETWORK

tion decreases, and measurements of the length of the indentation can be translated into highly accurate determinations of wear. This method has the following advantages: (1) as growth or distortion do not affect the result, only actual wear is measured; and (2) the high precision—a one-hundred-thousandth of an inch wear is detectable—shortens the test duration, and makes it possible to obtain comparative wear determinations before any gross change in engine condition has occurred. The principal drawback of the method arises from the fact that the wear mark is quite small, hence inhomogeneities in the cylinder wall materially affect the result in the case of any given mark. To offset this, marks were made at 12 azimuthal locations at each of four levels in each engine cylinder.

In order to simulate average operating conditions, the bank of five wear-test engines, including three makes, was operated on a cycle comprising four periods in which the engines operated 1½ minutes idle and 3½ minutes at road load at 40 mph, and a 10-minute shutdown period during which refrigerated water was circulated through the engine jackets. Measurements showed that this cycle duplicated the results of lengthy road tests very well. It was found necessary to control the coolant temperature during shutdown quite closely. It was also found that atmospheric humidity had an effect on wear, presumably through its effect on corrosion.

None of the substitute fuels gave as much wear as did gasoline. The average wear with gasoline and with alcohol at the various levels is plotted in Fig. 7. Results with the other substitute fuels were about the same as with alcohol. It was also found, as has been reported by many investigators, that the wear increased rapidly at lower temperatures. This effect, which was quite pronounced below 50F, is presumably caused by accelerated corrosion during the shutdown period. The wear on the starting-test engine, which operated at temperatures from +60F to —20F, was many times that of the wear-test engines.

Oil dilution was not detectable with the substitute fuels, although several per cent dilution occurred when operating on gasoline. Contamination of the oil occurred only with alcohol of very low proof, with which an excessive amount of water found its way into the crankcase, and formed an emulsion with the oil. Engine deposits were greatly reduced when operating on the substitute fuels. The average oil-free deposit in 40 runs on gasoline was 27.56 grams; for 14 runs on alcohol, it was 4.96 grams. Part of this reduction can be ascribed to the fact that only the gasoline contained tetraethyl lead, which catalyzes the formation of engine deposits, as well as adding lead salts directly to the deposit. Another part of the reduction in all probability arose from the lesser dilution of the lubricating oil when operating on the substitute fuels.

Specific tests showed that the substitute fuels did not have a deleterious effect on the fuel pump diaphragms, and that tank evaporation loss would be less than with gasoline. In the course of over two years intensive testing, no operational difficulties were encountered which could be charged to these fuels. Two cars, operated in daily service for several thousand miles each on the substitute fuels, performed satisfactorily and have continued to do so on gasoline since this phase of the work was concluded two years ago.

Tests on Gaseous Fuels

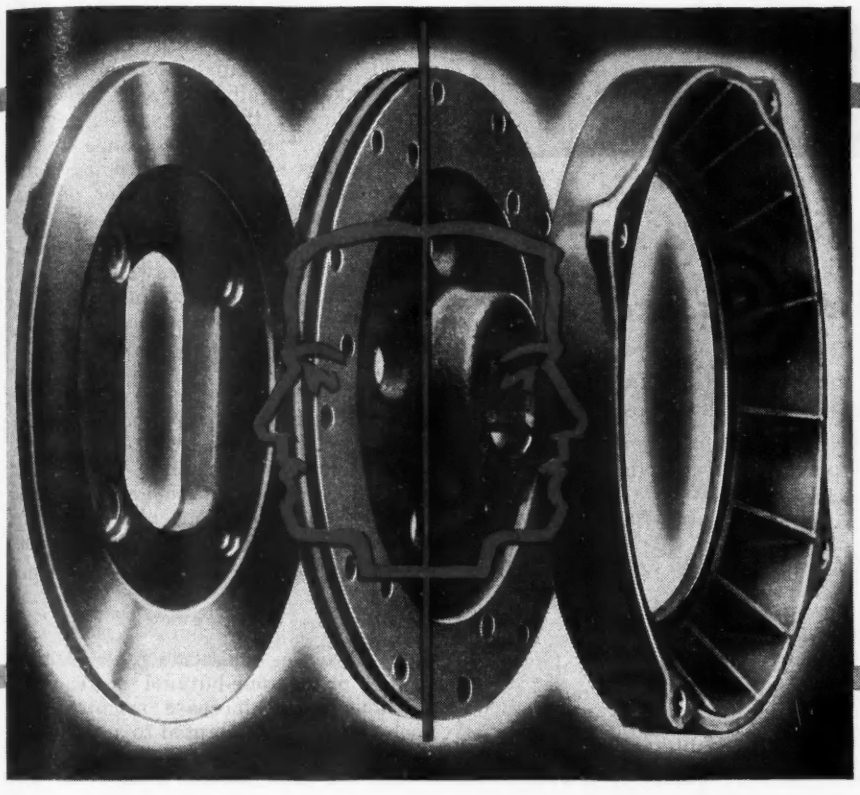
A series of tests was made on an engine equipped to operate on either gasoline or producer gas from charcoal. As shown by Fig. 8, only a little over half as much power was obtained when operating on generator gas as on gasoline. The comparative consumption of charcoal and of gasoline at various loads at 1800 rpm is shown in Fig. 9. The specific fuel consumption of charcoal is nearly twice that of gasoline, over the load range attainable with both fuels. At 12.5 bhp (about one-third load for gasoline), one gallon of gasoline could be replaced by roughly 11 lb

(*Turn to page* 66, *please*)

Every Wyman-Gordon forging is quality controlled . . . and behind every Wyman-Gordon forging stands the broadest and longest experience in the drop forging industry . . . Wyman-Gordon forgings are made today from five to five hundred pounds.

WYMAN-GORDON
WORCESTER • MASSACHUSETTS
HARVEY, ILLINOIS DETROIT, MICHIGAN

Because the DISC is 2 FACED...



Greater Braking Power

Less Pedal Pressure

No Brake Drums

Square inch for square inch, there is just twice the brake lining area in a Disc Brake... that's why engineers for years have recognized the basic advantage of the Disc Brake Principle.

Now, in the Lambert Disc Brake, this disc principle has been successfully advanced in its development and utilized for Hydraulic, Air and Mechanical Brakes. A further important development is the Lambert self-energizing unit. Included in these brakes, it makes possible the utilization of the vehicle's momentum to increase braking power. Results: *brakes that require far less pedal pressure... function with equal effectiveness in controlling both forward and backward motion... eliminate all brake drum troubles* ...and many other advantages, all of which are described in the complimentary booklet available to those who have a part in the design and production of tomorrow's products requiring the latest in brakes.

for cars, trucks, buses, tractors, aircraft and industrial machinery

Lambert Disc Brakes

Air • Hydraulic • Mechanical

Products of a Division of the Auto Specialties Mfg. Co.

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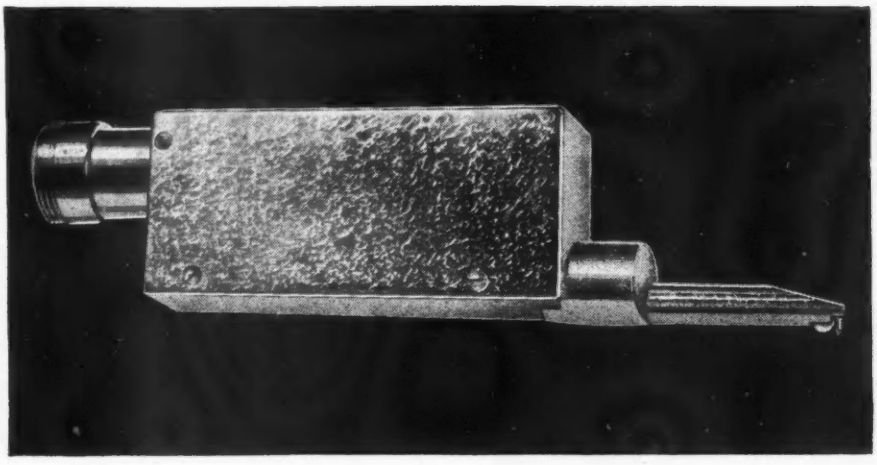
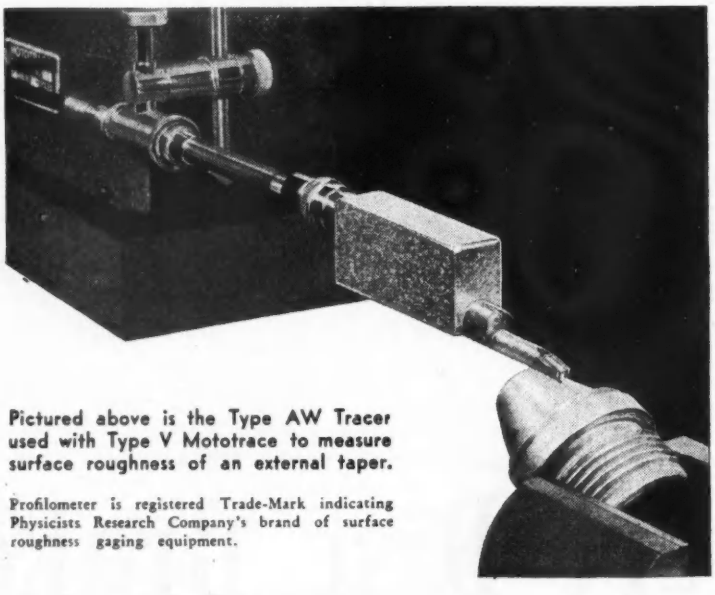


New Profilometer Tracer Extends Range of Roughness Measurement

Quality control of surface finish can be applied more conveniently to a greater range of work with the new, all-purpose Type AW Tracer for use with Profilometer equipment.

The particular advantage of the Type AW Tracer is that it is completely self-adjusting for use on all surfaces—flat surfaces, outside diameters, and inside diameters as small as ¼" ID. This Tracer can also be used on both internal and external tapered surfaces and on gear teeth.

The Type AW Tracer further rounds out the line of Profilometer equipment for the quick and efficient measurement of surface roughness. Surface finish is an important part of quality control and foresighted manufacturers are urged to talk with one of our field engineers about the advantages of Profilometer equipment. A letter to Physicists Research Company will enable our field engineer in your vicinity to arrange a visit to discuss and demonstrate the Profilometer. Profilometer catalog on request.



Pictured above is the Type AW Tracer used with Type V Mototrace to measure surface roughness of an external taper.

Profilometer is registered Trade-Mark indicating Physicists Research Company's brand of surface roughness gaging equipment.

PHYSICISTS RESEARCH COMPANY
343 SOUTH MAIN STREET - ANN ARBOR, MICHIGAN

of charcoal. It was noted that a much greater spark advance was required for maximum power with charcoal gas than with gasoline. Engine wear tests have not been made when operating on charcoal gas.

In an engine designed for its use, charcoal gas would be a very satisfactory fuel. The knock rating of the principal constituent, carbon monoxide, is above the highest recognized standard by present test methods. A suitable engine for charcoal gas would be supercharged to restore full power, and would be of compression ratio such as to take full advantage of the anti-knock value of this fuel. Such an engine would probably consume about eight pounds of charcoal in doing work done by a conventional engine on one gallon of gasoline.

Servicing of the gas generator constitutes the greatest drawback to the use of charcoal as an automotive fuel. The filters require frequent cleaning, even on the best grade of charcoal obtainable. In these tests, the interval between cleanings varied from 3 to 50 hours, averaging about 20 hours. Starting usually required about 2 minutes, and with proper technique, was not a problem. The personnel engaged on this phase of the work felt, however, that operation on any liquid fuel would be preferable to operation on charcoal.

Conclusions

Operation on substitute fuels such as alcohol or acetone-butanol is feasible, and should not increase maintenance. Such fuels can be adapted to a considerable range of climatic conditions by use of appropriate blending agents. Maximum power may exceed that with gasoline by a few per cent. Specific fuel consumption, or fuel mileage, is approximately proportional to heat of combustion. As hydrocarbons have higher heats of combustion than other liquids, no substitute liquid fuel will give as good mileage as ordinary petroleum fuels. Engines especially designed to exploit the anti-knock properties of substitute fuels would reduce this mileage difference. Where liquid fuels are not available, charcoal gas can be used in automotive equipment, at a sacrifice of nearly half the power, and with a notable increase in maintenance required.

More than Half of Nation's Tires are Now Synthetics

More than half of all the estimated 100 million automobile wheels "still rolling" on American streets and highways are now rolling on synthetic rubber. Substantially all passenger-car tires made and sold since the fall of 1943 have been all-synthetic in rubber content and about 85 per cent of the "camelback" used in retreading and recapping in that same period also has been synthetic.

New Production Equipment

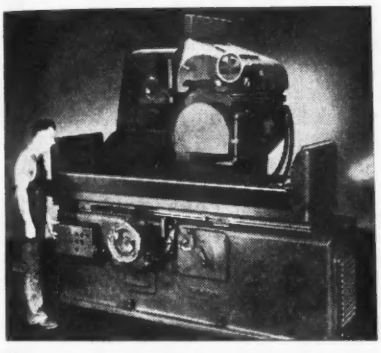
(*Continued on page* 38)

is introducing a new power hydraulic press.

With the traveling ram at one end of the press, the crane can lower heavy work into place on the machine and then the traveling ram can be placed over the work wherever required.

The traveling ram rolls on four ball bearing equipped wheels and the balanced ram assembly is said to roll with remarkable ease. The table is equipped with "V" slide on which are mounted spring loaded centers and checking rolls.

A FULLY automatic crush form contour grinder is now in production at the Thompson Grinder Co., Springfield, Ohio. This machine was designed

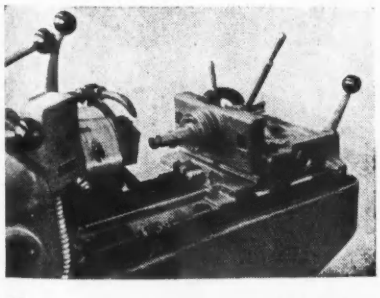


Thompson crush form contour grinder

for mass production of highly complicated contours, but it can mass produce conventional surface grinding jobs as well.

Thompson crush form contour grinders may be semi-automatic or fully automatic depending on the application. However, the machine illustrated was designed for mass production and incorporates electrically actuated and controlled grinding and crushing cycles, completely interlocked. Aside from lowering the head for contact between wheel and crusher roll for crushing and truing, operation is fully automatic and after original setup the operator simply presses a series of starter buttons to put the machine through its various cycles of operation.

Special Holding Fixture Speeds Production



The accompanying illustration shows a special workholding fixture developed by the Landis Machine Co. for use with its Landmaco threading machine for threading fuze adapters. The concentricity between the thread of the adapter, which screws into the nose end of the shell, and the bore of the adapter must be held to close tolerances. This special workholding fixture provides a means for maintaining these close tolerances with a simplicity of operation which assures maximum production possibilities.

ILLUSTRATED is an adaptation of a heavy-duty Baker drill for a special purpose drilling job when fitted with a special drilling head and fixtures by the Buhr Machine Co., Ann Arbor, Mich. As adapted by Buhr the machine is designed for drilling a group of 4590-¼-in. holes in an aluminum aircraft cooler plate. The drilling head has 51 water-cooled spindles. The clamping fixture holds 10 parts at a time and is mounted on a compound indexing table for positioning the parts to 65 different stations. The machine is provided with a safety feature to make sure that drills cannot feed down until the index table is locked in place.

(*Turn to page* 70, *please*)

BOTH EFFICIENT... AND *DEADLY ACCURATE!*

War birds of the United States Navy are writing their own glorious saga of their accomplishments. The men who fly them, and the planes themselves, must be fully efficient and deadly accurate in the perfection of their workmanship.

Those of us who are privileged to manufacture a portion of the supplies needed by both the Navy and Army airmen realize that we, too, must be efficient and accurate in the goods we produce. An "Arresting Hook" must work. It cannot fail. It suffers tremendous strain whenever a war bird alights in its "flat top" nest.

Arresting Hooks for Naval aircraft are one of several hundred highly stressed and precision parts we forge, weld and assemble for the war program.

The skill, craftsmanship and facilities necessary to produce these items can also serve you. Just write to us, today.

BUY UNITED STATES WAR BONDS AND STAMPS

*** AIRCRAFT MECHANICS** INC.

COLORADO SPRINGS, COLORADO

DESIGNERS ... ENGINEERS ... MANUFACTURERS

BIMETAL CONTROLS

—an Expanding Field of Peace-time Usefulness

The makers of temperature responsive controls—now playing an indispensable part in winning the war—will take an even greater part in building a better postwar world.

The demands of Industry for devices to control processes, to assure exact temperatures, to protect machines or motors against heat or stress—

The demands of Transportation for proper temperatures in both passenger cars and in freight-cars carrying perishable goods, as well as for giving the "green light" to over 500,000 miles of rails, 24 hours a day—

The similar demands of aviation, and even of our private automobiles, in which there are now more than 16 applications of bimetal control; and the insistent demands of our homes for more and better automatic home appliances—

From all these sources the builder of thermostatic controls may confidently expect a flood of orders when peace comes again. And in addition, he may rely upon many new developments in which Chace Thermostatic Bimetals can profitably be used. Over 20 years of Chace experience will be at his command.

W. M. CHACE CO.

Manufacturers of

Thermostatic Bimetals and Special Alloys

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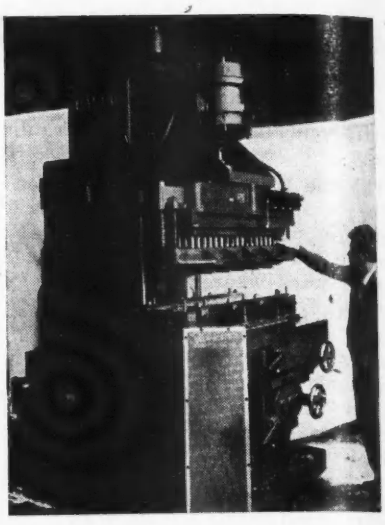


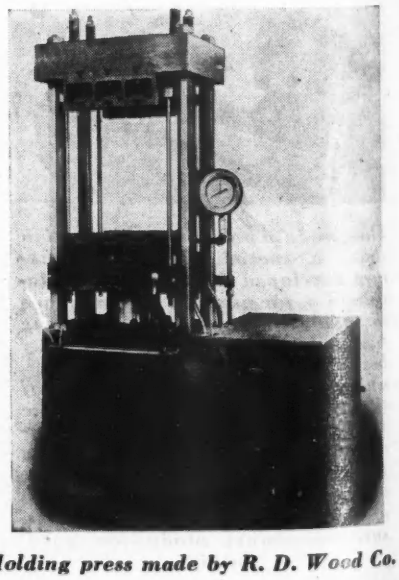
Baker drill with special drilling head

All of the gears in the drill head are shaved and induction-hardened for long life and trouble-free operation. A coolant pump provides the stream of coolant for the drills, the flow being automatically shut off when parts are being loaded or unloaded in the fixture. This machine has a productivity of 150,000 drilled holes per hour.

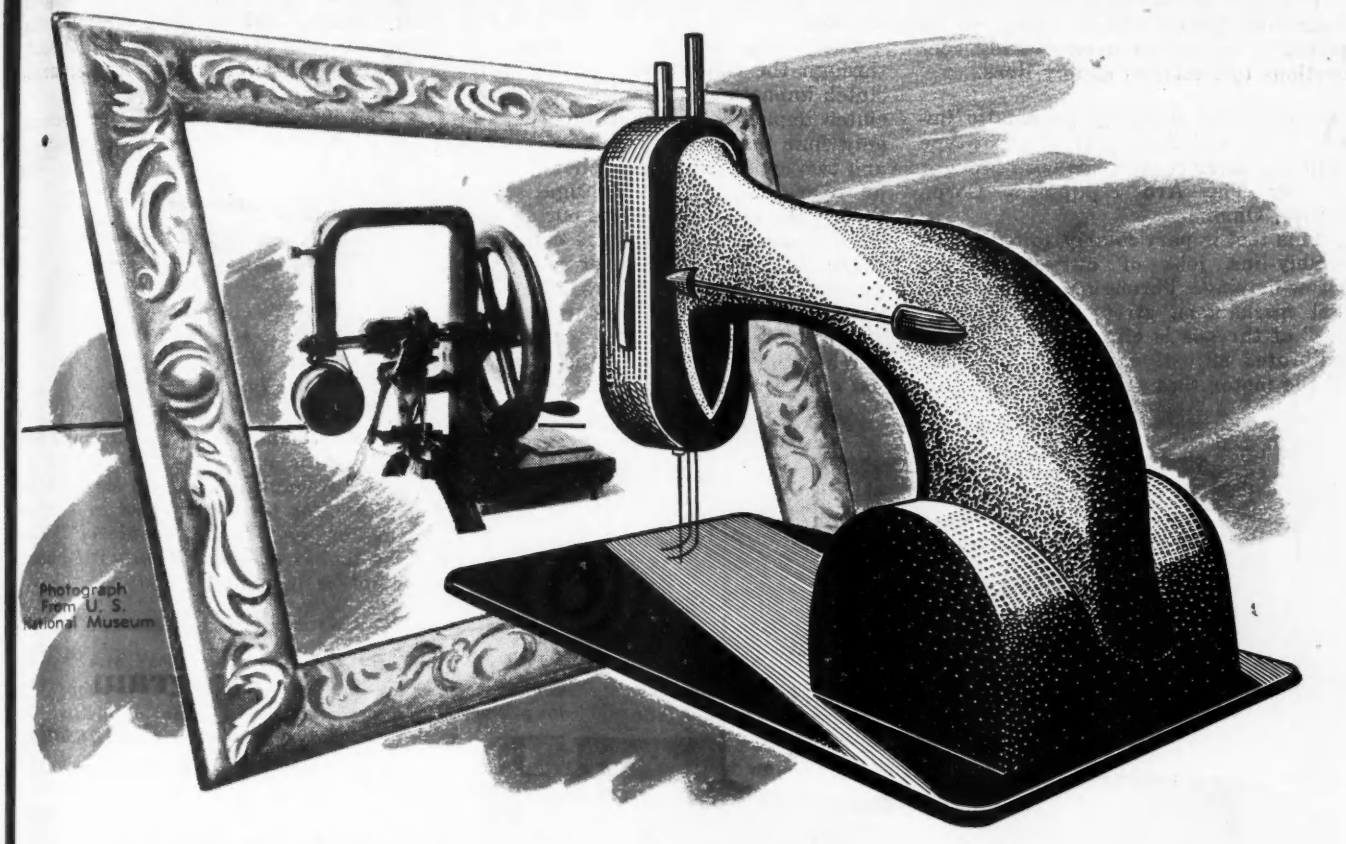
R. D. WOOD CO., Philadelphia, Pa., has placed on the market a 50-ton, self-contained molding press, for the molding of plastic products. It may be operated at any required pressure from 200 psi to 1000 psi, with corresponding tonnage variations of 10 to 50 tons through adjustment of pressure control hand wheel. The press operation is controlled by a lever-operated four-way piston-type valve arranged to exhaust automatically by a timer controlled solenoid.

The pressure is supplied by a duplex rotary piston pump, driven by a 3-hp, 1200-rpm motor. Pump has a low pressure capacity of 34 gpm at 150 psi and a high pressure capacity of 3.68 gpm at 1000 psi.

(*Turn to page 72, please*)



Molding press made by R. D. Wood Co.



SMOOTH SEWING AHEAD

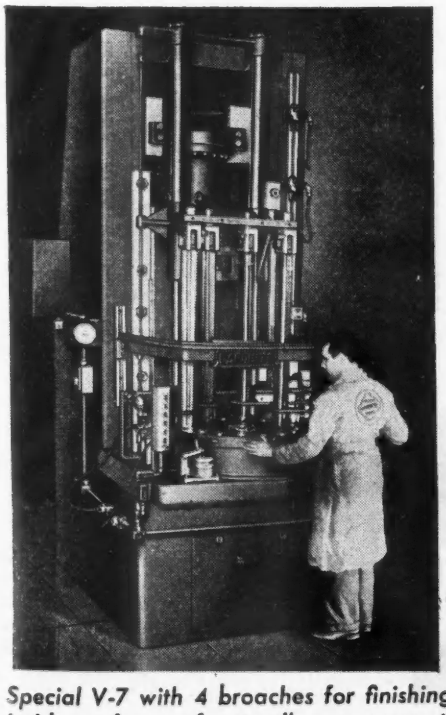
Tomorrow's streamlined sewing machines will hum busily in millions of postwar homes . . . for many of their precision parts will be mass-produced speedier, better and more inexpensively by modern broaching methods.

Scores of leading manufacturers, desiring maximum efficiency in the production of their postwar products, have placed their problems squarely upon the broad shoulders of the Lapointe engineering staff.

In each instance, Lapointe experts made a thorough study of both product and plant before submitting a recommendation. Usually, it disclosed how a switch to broaching of precision parts would bring about a substantial saving in money, time and valuable floor space. Such a recommendation should be of value to you, too, so contact the Lapointe engineering staff without delay.

★

IF YOU PLAN FOR TOMORROW . . . CONSULT LAPOINTE TODAY



Special V-7 with 4 broaches for finishing inside surfaces of propeller component.

THE Lapointe MACHINE TOOL COMPANY

HUDSON, MASSACHUSETTS • U.S.A.

THE WORLD'S OLDEST AND LARGEST MANUFACTURERS OF BROACHES AND BROACHING MACHINES

The press is furnished complete with indicating gages and is ready to be placed in operation upon making connections to electrical supply lines.

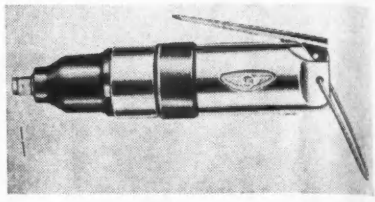
A NEW ¼-in. capacity pneumatic impact wrench with straight-type grip and lever control has been brought out by The Aro Equipment Corp., Bryan, Ohio.

This tool is particularly suited to assembly-line jobs of nut-setting and screw-driving. Through its torque control mechanism, stretching or "burning" of threads is eliminated. It has a calibrated adjusting screw on the side of the motor that enables the operator to set any bolt or nut to any desired tension.

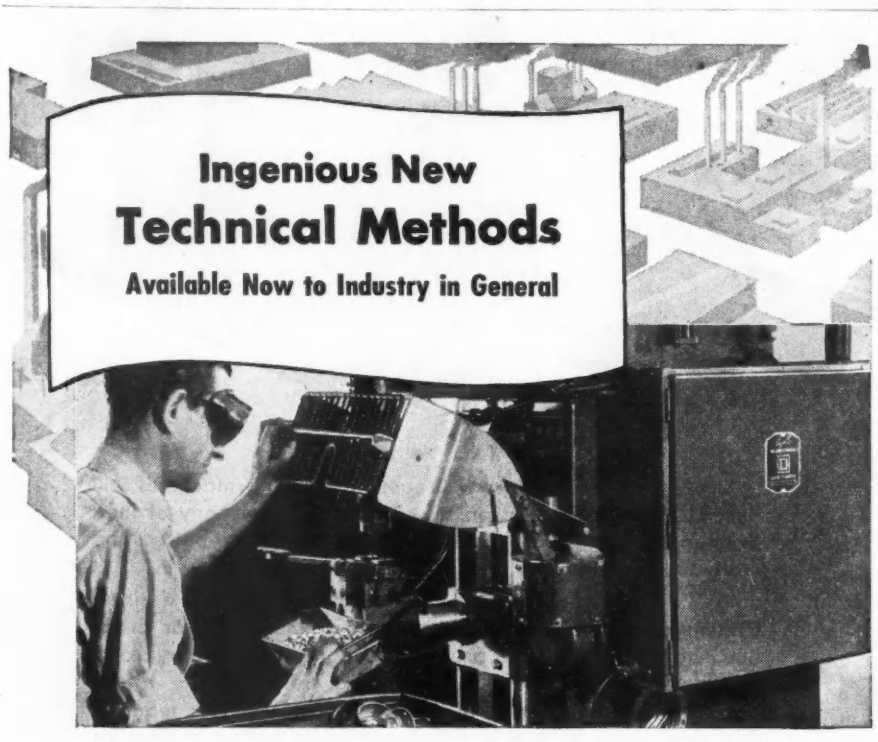
The control is obtained primarily through the construction of the roller clutch impacting mechanism. The roller clutch impacting mechanism consists of only four major parts—anvil, hammer and two cylindrical steel rollers. When in operation, the centrifugal force throws the two steel rollers out against the hammer where they are caught in shear between the hammer and anvil members. This transfers the full torque through to the work in the form of a sudden impact.

When the selected torque is obtained, the rollers rebound from the anvil face and do not allow the hammer to engage for impact. This method of impacting prevents any stretching of the threads on either the stud or bolt and guarantees maximum torque.

The Model 3012 has a ⅜-in. square drive with capacity for ¼-in. bolts and nuts, weighs only 1¾ lb, and is 6¾ in. overall in length. Its small size enables the operator to use the tool in corners or other hard-to-get-at places. This same tool is also available with button control or in pistol grip type.



Aro impact wrench



Now! Projection Welding of Two Studs to Housing in One Operation!

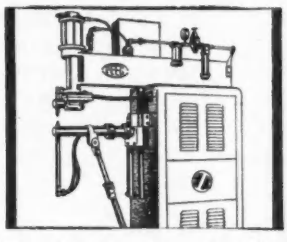
The series of P-20 Peer Welders were developed to provide manufacturers of sheet metal and wire products with automatically air operated machines capable of high speed precision projection and general spot welding. They are sturdily constructed, low priced, direct air operated, press type machines.

Shown above, is a Peer P-20 set up with safety guard which is so adjusted that, when lowered, it trips the switch and causes the welder to pass through a complete welding cycle before the machine automatically lifts the guard and stops, ready for the next operation. Other means such as a foot-switch control, can also be used to actuate the welding cycle.

The standard cylinders furnished with these welders provide nominal electrode force up to a maximum of 1000 lbs. Pressures are easily adjusted by the air pressure regulating valve. The welders may be operated with strokes suitable for work at hand within the range of from 0" to 3".

Shown at right, is the wrapper from a package of Wrigley's Spearmint Gum. This famous wrapper will remain empty until conditions permit Wrigley's Spearmint manufacture in quality and quantity for everyone. Wrigley's Spearmint Gum, will, one day, be back as "a help on the job" to workers in industry. Until then, we ask you to remember this wrapper as a guarantee of finest quality and flavor in chewing gum!

You can get complete information from Pier Equipment Mfg. Co., 8 Milton St., Benton Harbor, Mich.



Air Operated Press Type Spot Welder

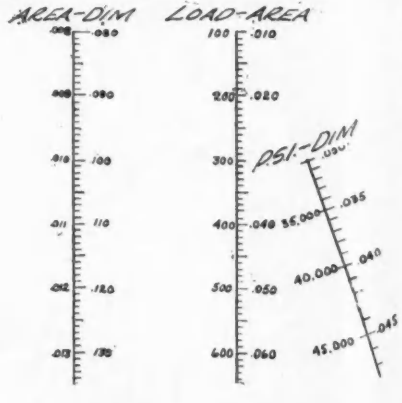
Remember this wrapper

Z-82

Ryan Nomogram

Speeds Computation of Tensile Strengths

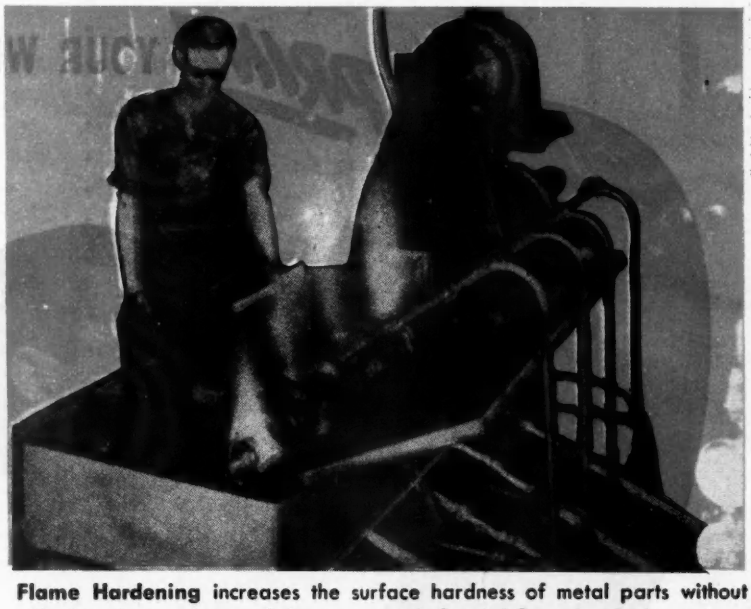
A NOMOGRAM designed at the Ryan Aeronautical Co. is said to save 95 per cent of computation time in checking aluminum test bars. The procedure for using the nomogram is as follows: (1) The cross-sectional area of the test bar is determined by locating the width and thickness dimensions on the two scales marked "dimensions," laying a straightedge between these points and reading the area from the middle scale where the straightedge intersects it. (2) Locate this area figure on the first scale and plot the yield or ultimate load, obtained from a test on the tensile testing machine, on the second scale marked "load." (3) Lay a straightedge between these points and read the tensile strength in psi from the third scale where the straightedge intersects it.



Ryan nomogram designed to compute tensile strengths quickly.

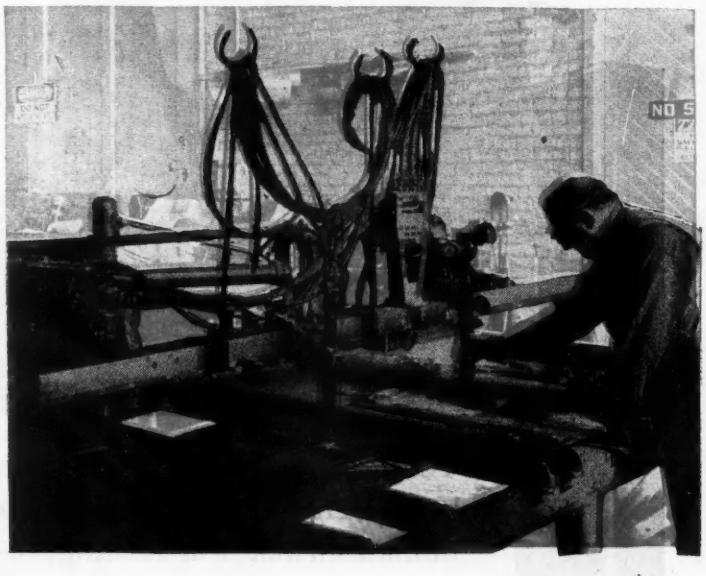
Production of Metal Parts

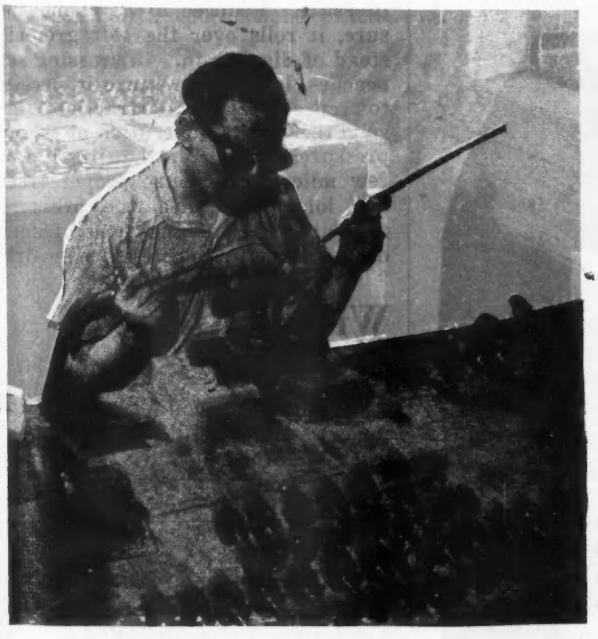
Arc Welding has clearly proven its ability to reduce the weight of metal parts while providing maximum joint-strength. The aircraft beaching gear shown here are typical of the many parts now being fabricated by arc welding.



Flame Hardening increases the surface hardness of metal parts without affecting the toughness of the core metal. Special flame-hardening set-ups are easily devised for localized hardening of large or small parts at points of heaviest wear.

Machine Gas Cutting speeds the shape-cutting of a wide range of steel parts of any commercial thickness. Thin gauge parts may be stack-cut in quantity with remarkable uniformity and accuracy. Airco makes gas cutting machines in sizes for every requirement.





Oxyacetylene welding is widely used for welding light-gauge metals of virtually every analysis. This method has a host of applications in aircraft and automotive manufacturing.

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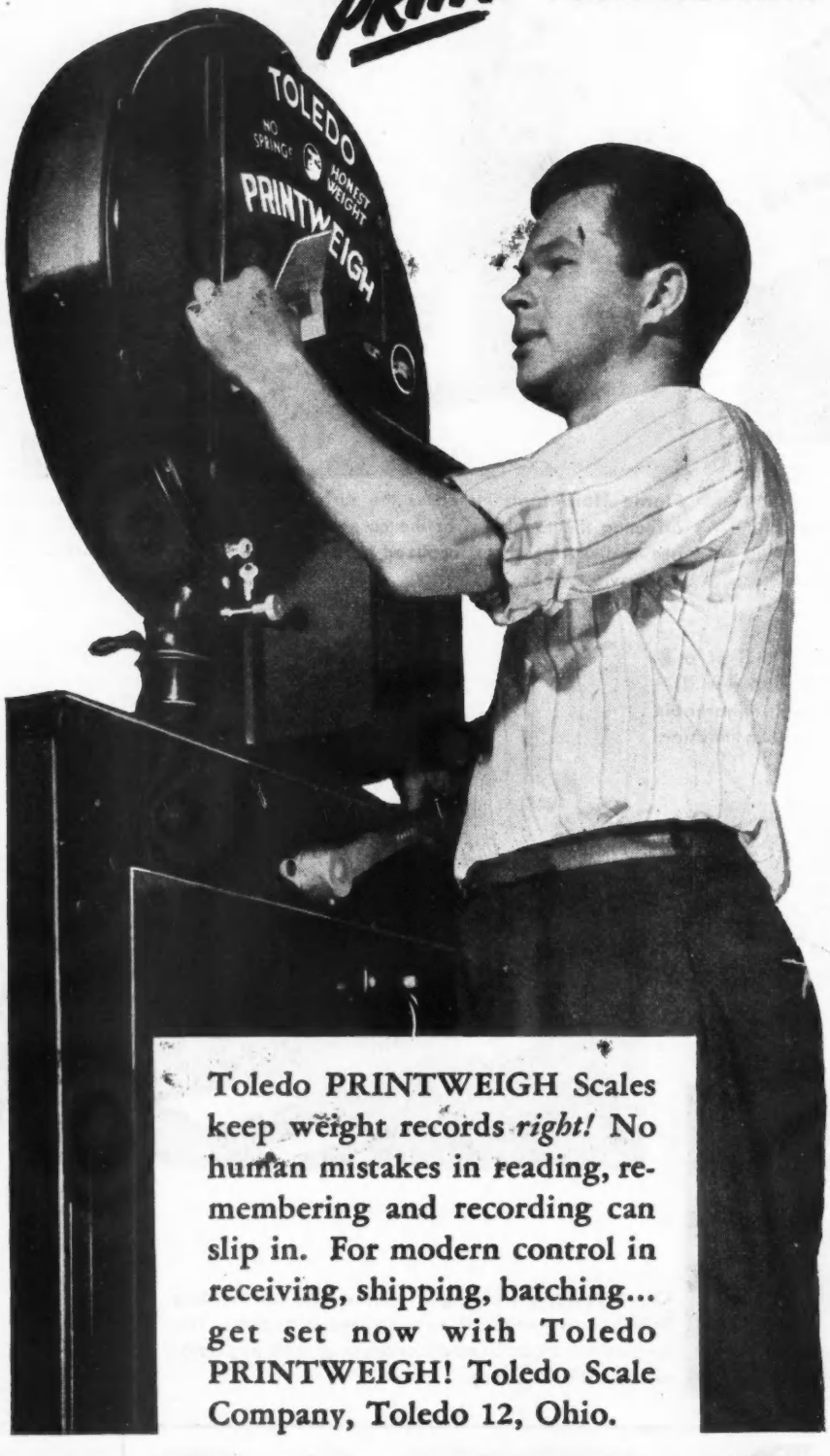

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TOLEDO

HEADQUARTERS FOR SCALES

Tire Inflation

(*Continued from page* 39)

the two members and insures long life for both the joint and the air seal.

Special precautions were taken to seal the unit against sand and salt water. A large spring-loaded seal of synthetic rubber is extremely effective in preventing the entrance of salt water. Its unique design permits the release of pressure from within caused by the rapid expansion of heated air on when the unit is lubricated. An auxiliary outer seal prevents the entrance of dust or water-borne sand. Controls for operating the system are accessible to the driver. The main control valve for inflating or deflating is located on the instrument board directly in front of the driver. To the right is the tire pressure gage which shows tire pressure at a glance. Just above the gage is a plate giving the correct operating pressures for various ground conditions. Individual valves for each of the six air lines are located on the left side of the gunner's seat within easy reach of the driver. These are used to shut off one or any combination of air lines to the tires in order to maintain pressure or to force more air to a damaged tire.

The Duck is equipped with an 11.00 x 18 desert-type tire which has relatively few plies. This permits the tire to flex easily and to increase considerably its ground contact area when the air pressure is reduced. For highway operation, the tire is inflated to 40 pounds pressure. Reduced to 12 pounds pressure, it rolls over the soft ground instead of digging in. In crossing sandy beaches, low tire pressure is necessary to secure flotation and traction, but beyond the beaches, operation at these low pressures would ruin the tires in a very few miles. To insure proper traction and longer tire life, the pressure is regulated to suit the type of terrain over which the vehicle is being driven.

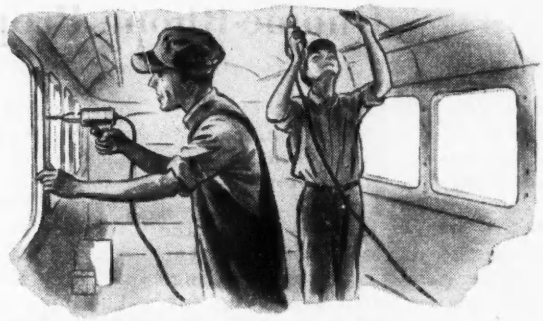
Willow Run

(*Continued from page* 51)

Plant clearance at Willow Run is now underway and still will take a few weeks to finish. Since Kaiser-Frazer has not yet announced its policy on whether it will buy or manufacture component parts, there is little indication of the size of the tooling job required. However, it is evident that even though engines, transmissions, axles and other complicated assemblies are purchased from outside sources, the tooling and equipping of an automotive plant for assembly requires several months and a hefty outlay of capital when starting from scratch. About the earliest production could start after acquisition of the plant would be six months, according to veterans in the automotive field, and even to accomplish that would require the most optimum conditions.

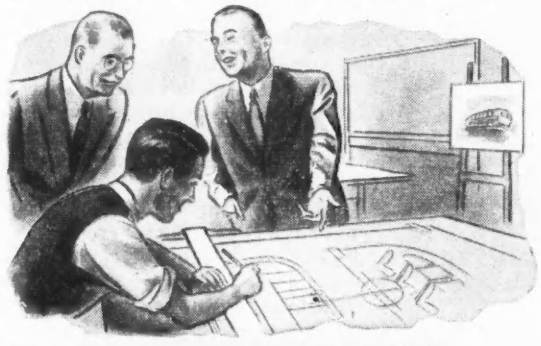
BURRS NO LONGER SNAG!

Before Phillips Recessed Head Screws were used for trim and seat assembly in this motor bus, burrs on slotted screws snagged passengers' clothing, caused many nuisance complaints. In spite of extra time for slow hand driving, and smoothing heads, some burrs got by.



NO ASSEMBLY LAG!

With Phillips Screws, burr-trouble ended, and *savings* began – as much as 40% in assembly time and labor, because power driving became practical. Also saved was the time formerly wasted disassembling, refinishing, and reassembling parts scarred by driver skids.



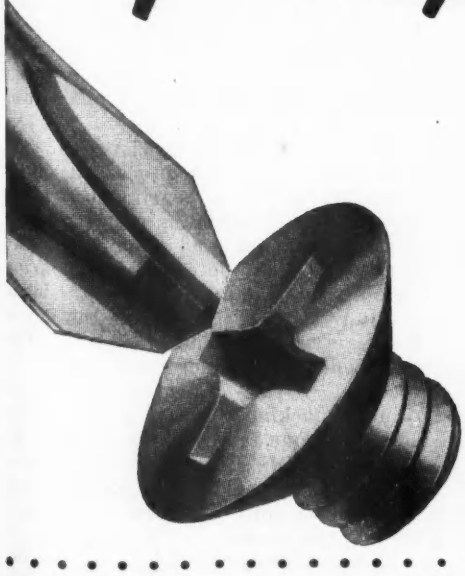
PLANS GET O.K. TAG!

Because Phillips Recessed Head Screws take heavier driving pressures without danger of burring, driver skids, or slant driving, fastenings are stronger, more rigid than with slotted screws. Designers are freed of slotted head handicaps, can often reduce number of screws needed.

APPROVAL'S "IN THE BAG"!

Burr-free Phillips Screws are not only kind to clothing . . . the Recessed Head on exposed surfaces looks better, blends with the practical smartness of modern design. Give your product this cost-trimming, customer pleasing sales appeal!

It's Phillips — the engineered recess!



In the Phillips Recess, mechanical principles are so correctly applied that every angle, plane, and dimension contributes fully to screw-driving efficiency.

. . . It's the exact pitch of the angles that eliminates driver skids.

. . . It's the engineered design of the 16 planes that makes it easy to apply full turning power – without reaming.

. . . It's the "just-right" depth of recess that enables Phillips Screw Heads to take heaviest driving pressures.

With such precise engineering, is it any wonder that Phillips Screws speed driving as much as 50% – cut costs correspondingly?

To give workers a chance to do their best, give them faster, easier-driving Phillips Recessed Head Screws. Plan Phillips Screws into your product now.

PHILLIPS *Recessed Head* SCREWS

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Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
The Steel Company of Canada Ltd., Hamilton, Canada
Wolverine Bolt Co., Detroit, Mich.

Gnome-Rhone Propeller

(*Continued from page 37*)

drive worms. These steel worms are mounted at the front of the hub on two SKF taper-roller thrust bearings and at the rear on plain bronze sleeve bearings. Bearing outer races and liners are pressed into the hub at the front and rear, respectively. A cap which covers the front worm bearings has an integral prong projecting forward to position and support the propeller spinner. The worm drive pinion gear is splined to the worm shaft and the pitch indicator drive gear, incorporating a shaft, is fitted over the pinion. Apparently the shaft of the indicator gear is designed to absorb a certain amount of torsional load. It extends through the hollow worm to the forward end before being secured against rotation by a pin.

Three holes in the rear face of the hub, position spring-loaded, pointed steel plungers which contact the teeth of the transverse pinion gears to aid in maintaining tooth-by-tooth rotation. Other sections of the hub are profusely drilled with holes and fitted with studs to mount the spinner and various locks. Three grease fittings in the front face of the hub direct grease to the base of the hub socket next to the spider arms.

The center bore of the hub is splined to fit an engine shaft slightly larger than an SAE No. 30. The rear cone seat is cut into the hub, while the front cone face is part of a sleeve pressed into the hub bore. One piece front and rear cones are made of aluminum-bronze alloy as is the hub retaining nut. A locking sleeve, snap wire and shield cap fit over the retaining nut when it is in place.

A section cut from the hub wall was analyzed to determine metallurgical characteristics. Microexamination indicated a coarse sorbitic structure. Also, a .010 in. partial decarburization of the hub surface was found. This result of heat treating is considered detrimental to the strength of metal structure, particularly propeller hubs, and has instigated extensive prevention methods in the U. S. A section of the hub wall, when subjected to hardness readings, was found to be of a lower hardness than American-made hubs. The hardness readings of the section are given in Fig. 7.

Blade

The Gnome-Rhone blade is machined from a solid dural forging of conventional planform and section. A cup-shaped retaining nut and inner and outer thrust bearing races are placed over the blade shank during manufacture and the butt end of the blade is upset. A shoulder is then machined on the upset portion, providing a seat for the inner thrust bearing race. The center of the blade shank is bored for a distance from the butt end into the shank. An aluminum-bronze bushing is then pressed into the shank bore. This bushing fits over the hub spider arm when the blade is in place, transmitting torque and bending loads from the blade to the hub spider.

The thrust bearing consists of 52 steel roller bearings fitted into a split dural retainer. Individual bearing sockets are cut into the retainer halves from their outside diameter and each holds two bearings. The outer thrust bearing race fits into the upper end of the blade retaining nut. Fig. 8 shows the entire blade retention assembly exploded. The outer end of the blade retaining nut is recessed to take a woven, grease retaining packing. A split dural ring acts as a cone for the split dural packing nut which screws into the retaining nut to depress the packing. Steel pins in the split cone and nut assure correct alignment.

A bronze worm wheel is positioned on the blade butt by eight sleeve nuts fitting studs screwed into the butt. A steel spacer positions and protects the worm wheel which is machined with teeth around its entire circumference. Projections on the inner end of the wheel contact a bottoming ridge ma-

(*Turn to page 80, please*)

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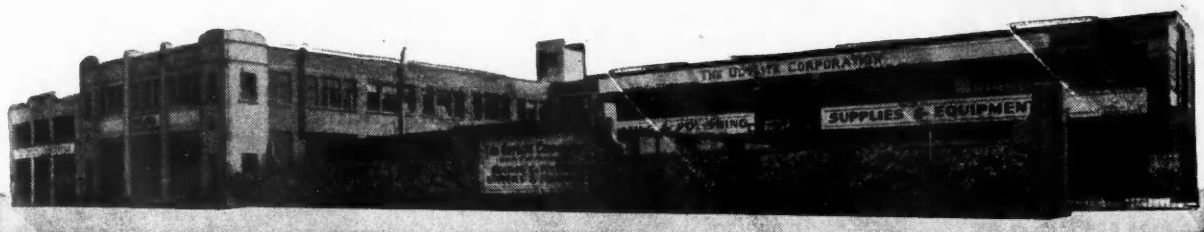

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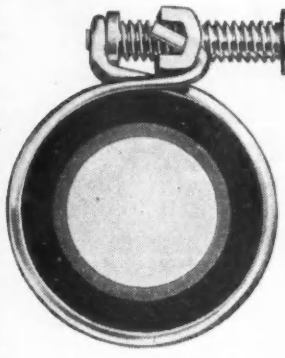

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Clamping power, even on synthetic hose, is unaffected by rough castings or variations in hose diameter and resistance. The "360" tightens instantly. Its powerful pressure grip cannot be loosened by the most severe vibration.

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SAMPLE & BULLETIN No. 101

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chined in the floor of the blade socket. The assembled blade retention system may be seen in Fig. 9, a view of the hub with two blades installed and the third in the foreground. The cutaway section of the hub wall and worm and worm boss shows the compact fit of blade and worm assembly.

Appraisal

U. S. practice has found that coupling and uncoupling a propeller to a stationary engine nose case is not the most desirable means of varying pitch. The amount of mechanism required with this type is scarcely less than that required for a propeller utilizing an auxiliary source of pitch-changing power.

The rate of pitch change of this propeller is less than one degree per second at cruising speed, a rate which is not entirely satisfactory for combat aircraft. However, the quality of workmanship was found to be very high, and judging from indications of operational wear, no serious faults or areas of undue wear had yet become apparent. The weight analysis indicates that the propeller alone is within the weight-for-horsepower range of present day controllable propellers using auxiliary power for pitch change. A breakdown of the weight follows: Hub—48 lb; Blade assemblies—97 lb; Hub mechanism—28 lb; Total—173 lb.

Crossley Diesel

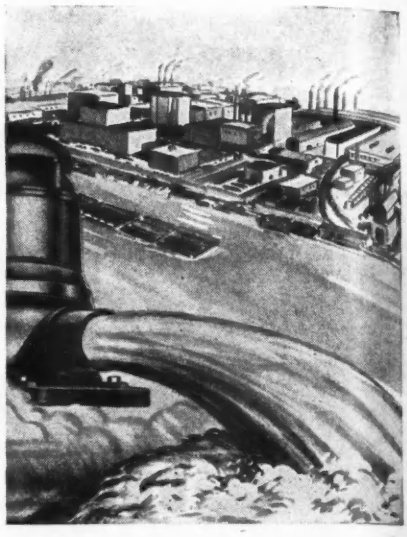
(*Continued from page* 27)

standard pressure results in considerable reduction of stresses on the fuel pump and other parts of the injection equipment, with correspondingly reduced wear and noise in operation.

Diagrams taken over several cycles on a Farnboro indicator show that a characteristic of the combustion cycle is its stability and uniformity, with pressures on consecutive cycles very closely related, which results in smoother and quieter running. From a noise and vibration viewpoint the engine is claimed to be comparable with a good gasoline engine of corresponding type and size.

Another important effect of this design is that the rate of pressure rise is greatly reduced, and the ratio of compression to combustion pressure is also much lower, enhancing the smoothness of running and reducing bearing loads. With a compression pressure (15.6 to 1 ratio) of 600 psi, the maximum combustion pressure is only 815 psi, a ratio of 1.358 to 1, as compared with pressures of 555 and 870 psi respectively, a ratio of 1.567 to 1 in the earlier Crossley engine. Pressure rise per deg of crankshaft angle is only 12.6 psi, compared with 26.5 psi, while the "knock angle" (crank angle movement after tdc) is 22 deg against 14 deg. Main and big-end connecting rod bearing pressures are thus reduced by from 10 to 20 per cent.

(*Turn to page* 84, *please*)



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In general, these results show that the new engine represents a closer approach to the true constant pressure combustion of the Diesel cycle. That combustion is efficient, is indicated by the fact that the specific fuel consumption is 0.35 Imp pt per bhp-hr at slightly less than full load.

Apart from the thermal efficiency as shown by fuel economy, the engine operates at such a low temperature that a radiator fan is not required either in summer or in winter under operating conditions in England, while the maximum temperature of the lubricating oil is so low that an oil of the lowest viscosity is used all the year round.

With a bore and stroke of 4.5 by 5.5 in., giving a piston displacement of 525 cu in., the engine develops just over 100 bhp at 1700 rpm. Its maximum torque is 4600 lb-in. at 850 rpm.

The cast iron cylinder block is mounted on an aluminum crankcase and has air-hardened cast iron "dry" liners. The detachable heads are in threes with overhead valves and downturn inlet ports. Valves are operated by roller cam followers, short pushrods and rockers from a high seven-bearing camshaft running in an oil bath tunnel alongside the top end of the cylinder block. The tunnel also houses the decompressor shaft. Silicon chrome alloy is used for both inlet and exhaust valves; the latter have renewable seats.

Connecting rods are of nickel chrome alloy and have the bearing caps secured by four bolts. Big-ends have the top half lined with "Cromet" (aluminum alloy) and white-metal lining for the caps. The seven-bearing crankshaft is machined all over, statically and dynamically balanced and fitted with a torsional vibration damper of the bonded-metal-to-rubber disk type. Crank pins are 3.0 in. and journals 3.25 in. in diameter. The main bearings also are composite, with lead-bronze lower and white-metal upper halves. The bearing caps are secured by extended cylinder block locating bolts, with two additional bolts for the rear and center bearings.

Distribution is by triple roller chain with automatic tensioner. The fuel pump is driven through a 2 to 1 single-helical gear from a chain-driven shaft, while the duplex gear type oil pump at the front also has chain and skew gear drives. The larger pair of gears in the oil pump, deliver at high pressure through two filters to the main crankshaft and big-end bearings and the wrist pins, while the smaller pair supply oil in smaller volume and at lower pressure to the camshaft bearings, distribution chain, overhead valve rockers and auxiliaries. There are two separate intake pipes leading from the sump to the pump sections, one, for the main section, having a floating uptake and the other submerged at a lower level. A full-flow pressure filter is fitted transversely under the front of the crankcase; it has no fins, for these are not required owing to the low operating temperature of the oil.

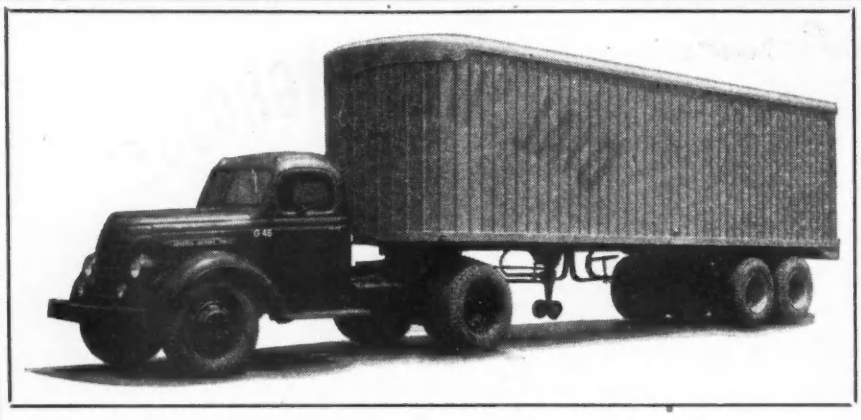
The fuel injection pump unit, supplied by a 2.0 imp gal capacity Autovac tank, is of conventional constant-stroke type, with governor control of minimum and maximum speeds. An air vessel prevents pulsations in the delivery line, which otherwise might have effect in reducing output at high speeds. Atomizers are of the spring-loaded automatically closed type.

Auxiliaries include a CAV axial type starting motor, 24-volt 8.0 in. generator (driven from either the engine or the four-speed transmission), vacuum pump for the brake servo, additional oil filter of the Autoklean (film) type connected to the brake pedal to rotate the filter elements to clear them, and oil-wetted air filter.

Unsalable Planes to be Scrapped

The prompt salvaging and scrapping of all commercially unsalable surplus aircraft in the United States, including the vast majority of surplus combat planes, was authorized by the Surplus Property Board.

In Special Order No. 11, SPB directed that all commercially unsalable surplus aircraft and related parts and equipment, other than those required for special purposes, be salvaged and scrapped.



CARTER-built Trailer Equipped with TUTHILL

HERE'S a trailer that any truck operator, owner or driver would appreciate—for it is built of *lasting steel!* Corrugated steel, strong, rigid, for the body—supported by TUTHILL Springs, made of *heat-treated, service-tested* alloy steel! What a combination!—used by CARTER MFG. CO., Memphis, Tenn., in this roomy, rugged trailer—steeled for rough, daily usage. Both main and auxiliary springs are TUTHILL—tough, strong, resilient.

Tuthill makes a complete line of leaf springs, standard or special. What are your requirements?

TUTHILL SPRING CO.

760 W. POLK ST. CHICAGO 7, ILL.

Quality Leaf Springs Since 1880

New Products

(*Continued from page 44*)

greatly improved surface appearance. The reduction of surface marks in 411 enhances appearance and adds brilliance and gloss. Welds are scarcely perceptible in the new material and are said to prove superior to regular polymers.

Full-Complement Overrunning Clutch

The Gear Grinding Machine Co., Detroit, Mich., is making a new overrunning clutch, called Formsprag, which consists of cylindrical inner and outer races, with the annular space between them filled with accurately formed sprags. Contact with both surfaces is maintained by an energizing annular spring at each end of the sprags.

When torque is applied all sprags are rotated at the same time, gripping both inner and outer races. Once torque is removed, all sprags release—instantaneously. Positive engagement and disengagement may be made hundreds of times per minute.

Due to the large number of sprags, localized stress is reduced a minimum, and wear is evenly distributed throughout all surfaces.

The torque carrying capacity of the Formsprag, in general, is equal to the torque carrying capacity of any shaft which has a diameter less than the diameter of the inner race. The simple design permits the greatest possible torque capacity for size and weight.

Plastic Station Wagon Bodies

John Tjaarda and Associates, Detroit, have designed and engineered a composite plastic station wagon type body. These bodies have been licensed to, and will be manufactured by, the Saginaw Body Manufacturing Co.

The most interesting part of the manufacture of the bodies is that the complete sub-assemblies can be either assembled in Saginaw, or direct on the automobile production line. This will, of course, allow these bodies to be shipped knocked-down anywhere in the United States or abroad.

All cars will be equipped with vacuum operated automatic windows and form fitting latex seats. They will be finished in wood veneer finishes. The body material is said to be impervious to weather conditions, lightweight, exceptionally strong, and with high insulation qualities.

New Pressure Transmitter

Trimount Instrument Co., Chicago, Ill., is offering a pressure transmitter which makes possible, for the first time, the recording of pressures on any continuous balance potentiometer. This instrument simplifies many pressure transmission problems and makes possible many studies heretofore impossible.

(*Turn to page 88, please*)

HOLTITE SPECIALS

These Special Fastenings and Parts were selected from thousands of items we are continually producing to convey an idea of the extensive range of our service.

If you are now using standard fastenings that are not fully satisfactory for the purpose, send us full particulars and we will gladly recommend Specials designed specifically for your particular application. Specially designed fastenings often eliminate extra parts and assembling operations while strengthening the assembly.

Special equipment, representing the latest improvements in high speed, precision machinery, together with experienced engineering talent assure the most precise, efficient Specials that can be produced. Send samples, specifications or blue prints for quotation.

50% SAVINGS
HOLTITE
—PHILLIPS—
Recessed Head Fastenings

As bit cannot slip from recessed head, spiral and power drivers can be safely used, even on finished parts, to cut your fastening time in half!

For regular fastenings select your requirements from the complete line of HOLTITE standard screws, bolts, nuts and allied fastenings, furnished with slotted head or HOLTITE-Phillips Recessed Heads.

CONTINENTAL SCREW CO. NEW BEDFORD, MASS., U.S.A.

By means of a special switching arrangement, more than one pressure can be recorded on the same instrument, which makes this transmitter particularly valuable where a large number of pressures are to be recorded simultaneously.

Installation of the pressure transmitter is said to be simple, involving only wiring instead of piping. Size and weight are small, and it is available for any type pipe fittings. This transmitter is usable for gases or liquids for pressures up to 1000 psi. No batteries are required, and the calibration is permanent. This pressure transmitter has a wide temperature range, and no amplification is required.

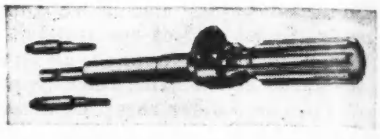
Pennsalt PRF Cement

A new resin-type cement, known as Pennsalt PRF cement, has recently been brought out by the Pennsylvania Salt Manufacturing Co., Philadelphia, Pa. This cement is a quick-setting, cold-hardening acid, alkali and solvent proof product composed of a liquid and a powder which, when mixed, react chemically to form a cement.

Pennsalt PRF cement has been designed specifically for bonding corrosion-proof brick and tile in uses where both acid and alkalis are encountered. Typical applications are laying floors and drains, and lining tanks in electroplating shops where a cement is required that will resist corrosive acids, alkalis and solvents.

Torque Screw Driver for Hand Assembly Jobs

A new hand tool has been added to the line of the Apco Mossberg Co., Attleboro, Mass. It is a torque screw driver for all hand-assembly jobs on sheet metal, plastics and light metal. Its basic principle and construction is identical with that of the Apco Mossberg torque wrenches, measuring tension by the relative longitudinal displacement of parallel steel bars. Inch pounds, in the case of the Apco Mossberg torque screw driver, are indicated directly on the dial. The range is from zero to 25 inch pounds. This torque



Apco Mossberg torque screw driver

driver comes with two bits, one for Phillips screws and one for slotted screws, together with an adapter for a quarter inch square socket to take wrenches for small nuts, studs and socket screws.

Utility Set of Mounted Wheels and Points

A new compact package of 12 mounted wheels and points in sizes most commonly used is now being offered to industry as a supplement to its present utility set of 20 mounted wheels and points by the Bay State Abrasive Products Co. of Westboro, Mass.

These utility sets are packaged in narrow one-piece boxes for the set of 12 and in two-piece packages for the set of 20 mounted wheels and points.

Foremen and tool supervisors will find these Bay State utility sets convenient for putting commonly used mounted wheels and points at operators' finger-tips—avoiding fumbling, delay and lost tools.

Eddy Current Clutch

The Eaton Manufacturing Co., Cleveland, Ohio, has originated an eddy current clutch which provides a controllable speed output from a variable speed or constant speed input. The device was developed for driving automotive and aircraft accessories such as fans, blowers, compressors, generators, pumps, windshield wipers, etc., directly from the engine at a substantially constant speed regardless of variations in speed of the driver.

Coolant for Super-Cut Diamond Wheels

A diamond wheel coolant specially prepared and compounded for use on Super-Cut Zurium bonded diamond

(*Turn to page 92, please*)

YOU'LL HAVE A LARGER GAGING SURFACE WITH THE NEW ROUND GAGES

ELLSTROM

When you use the new Ellstrom round gage blocks, practically all of the gaging surface can be utilized because there are no corners, as in the case of the square blocks. For example, the gaging area of a round block is .9970 square inch while the gaging area of a square block is .7917 square inch. Gage life is thereby increased.

Chromium plating increases gage life many times over ordinary steel gage blocks.

Use of the round shape gage virtually eliminates chances of tipping, causing possible injury to the gaging surface. "Flats" prevent rolling.

ROUND GAGES PRICES PER SET

Set No. 2-85-W	$464.00
Set No. 2-85-1	695.00
Set No. 2-81-W	437.50
Set No. 2-81-1	656.25
Set No. 2-35-W	222.50
Set No. 2-35-1	318.75
Set No. 2-36-W	259.35
Set No. 2-36-1	373.75

(Prices on individual blocks on request)

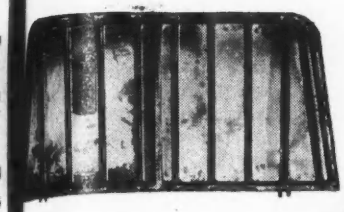
NOTICE ... We offer immediate delivery on rectangular gages.

CHROMIUM PLATED

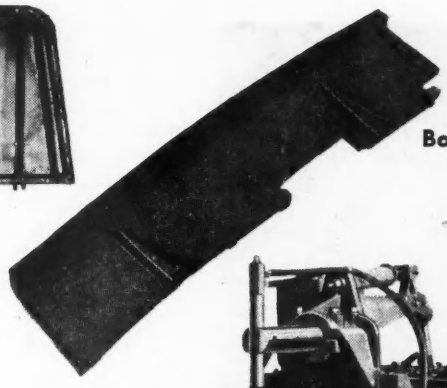
DEARBORN GAGE CO. 22037 BEECH STREET DEARBORN, MICHIGAN

Originators of Chromium Plated Gage Blocks

(Advertisement)



Cabinets and Doors



Body Panels

on these types® of

Federal

RESISTANCE WELDERS

Let us tell you How

MEMBER RESISTANCE WELDER MANUFACTURERS ASSOCIATION · RWMA

220 DANA ST.
WARREN, OHIO

VERSATILE MODERN PRODUCTION TOOLS

READY-TO-NAIL MOULDINGS

Decorative or utility type metal mouldings with steel brads permanently attached, ready for continuous nailing, are made on a high production basis with the aid of automatic resistance welding employing a press type welder developed by The Federal Machine and Welder Company. The moulding is automatically indexed for proper spacing and the brads automatically cut and fed from wire reels. They go on in a hurry, and they never come off. The process is adaptable to many sizes of moulding and brads or nails.

"SELF-FASTENED" FABRICATIONS

Heavy duty metal tool and tackle boxes are made in the modern manner without the aid of any fasteners other than weld nuggets of the fabricated metal. One manufacturer has devised a lid-locking box in which not only is the box itself completely resistance welded, but hinges, handles and even the removable tray are made without fastenings. Using Federal spot welders with variable electrodes, this method can be made highly flexible . . . profitable on small runs of a variety of sizes and styles of containers. Such welders, operated according to instructions, make fabrications that are well nigh indestructible . . . neat and modern in appearance.

USEFUL SPOT WELDER BOOK

Detailed descriptions of a complete line of rocker-arm type spot welders made by The Federal Machine and Welder Company, plus some interesting discussion of the type of work to which they are best suited, are included in a new book offered by this company. Designated as "Bulletin No. 4510", it contains helpful information on air-operated, motor-operated and foot-operated spot welders.

The new book gives a clear idea of what a rocker-arm spot welder is and what it can do. It combines data formerly available in a group of separate folders, and is designed to simplify the problem of selecting the type of spot welding equipment best suited to particular production set-ups. Free copies may be had on request.

SOLUTION TO
MATERIALS HANDLING

CLARK field engineers are qualified to survey your materials handling problems and recommend solutions. The pallet system with Clark Fork Trucks pays dividends in time and space savings. If you are interested in the most modern methods . . . Write Today.

CLARK TRUCTRACTOR
BATTLE CREEK, MICHIGAN, U.S.A.

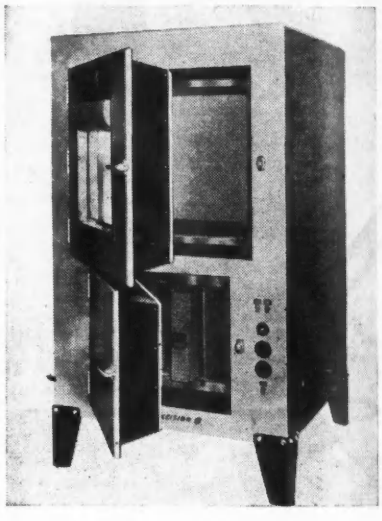
Products of CLARK • TRANSMISSIONS • ELECTRIC STEEL CASTINGS
AXLES FOR TRUCKS AND BUSES • AXLE HOUSINGS • BLIND RIVETS
INDUSTRIAL TRUCKS AND TRACTORS • HIGH-SPEED DRILLS AND REAMERS
METAL SPOKE WHEELS • GEARS AND FORGINGS • RAILWAY TRUCKS

wheels is offered by Industrial Abrasives, Inc., Chicago, Ill.

Super-Cut coolant is said to cling tightly to the diamond surface and form a film which prevents hot chips from imbedding themselves between the diamond teeth, so that wheels can clean without loading or glasing, and therefore cut free and cool.

Cold Cabinet with Heating Unit

The Precision Scientific Co., Chicago, Ill., has designed a new Vari-Temp cold cabinet. This cabinet is available in two sizes, 1 cu-ft capacity and 8 cu-ft capacity. It operates with dry ice and incorporates a heating unit in the cold chamber allowing a full temperature testing range of from —90 F to



Vari-Temp cold cabinet

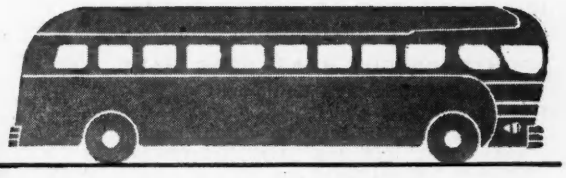
220 F. Thermal losses are kept at a minimum by completely insulating the inner wall from the outer wall.

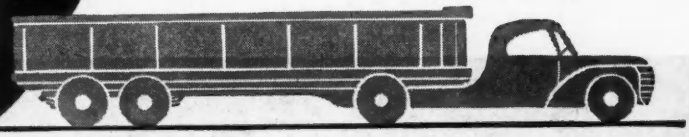
Constant temperature in the specimen chamber is insured by an air stirrer, which holds the temperature constant to ±1 F. This fan is automatically turned off when the door is opened to prevent a rapid temperature change. A blower circulates the air to and from the chamber.

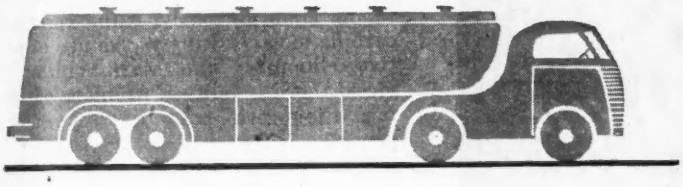
Protective Material for Bus and Truck Roofs

A ready-mixed protective material for bus and truck roofs will be marketed as No. 2700 Dolfinite aluminum waterproofing by the Dolphin Paint & Varnish Co., Toledo, Ohio. It covers solid with one coat over any surface and provides an attractive appearance. This material is of heavy body and high aluminum content but will brush or spray freely, flowing to a uniform surface. It is heat repelling, contains water and weather resisting liquids and can be used with or without primer.

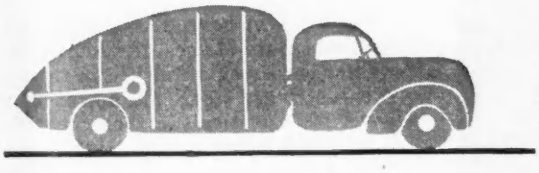
Going Places WITH Mayari R





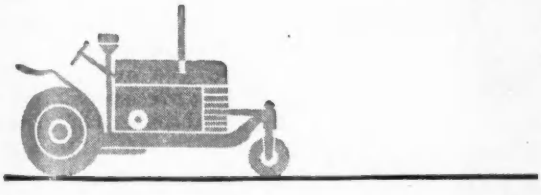


Automotive equipment designed and built with Mayari R, Bethlehem's high strength, low-alloy steel, is going places. Here are some reasons why:



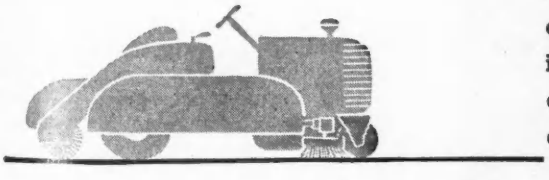
DEAD WEIGHT REDUCED AS MUCH AS 40%

One of Mayari R's important properties is its high yield point—almost twice that of mild carbon steel. Hence it affords the necessary strength, with lighter sections. This feature alone makes Mayari R worth thinking about. The weight saving—up to 40 per cent—that is made possible helps compensate for Mayari R's increased cost. Superior workability, easy weldability and feasibility of using it "as-rolled," without heat-treatment—these make the finished job comparable in cost with mild carbon steel.

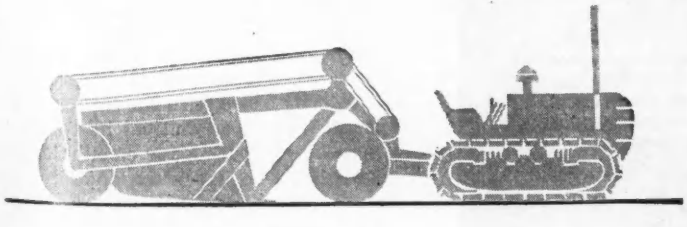


CORROSION RESISTANCE INCREASED

Mayari R's resistance to atmospheric corrosion is two to four times that of copper-bearing steel, five to six times that of mild carbon steel. In addition, Mayari R possesses great resistance to abrasion, and to impact, even at sub-zero temperatures. Tests indicate Mayari R's superior ability to hold paint. What this all adds up to, of course, is lower depreciation and maintenance charges—substantial long-term economies.



Send for illustrated catalog that will tell you more about Mayari R. Address the nearest Bethlehem district office, or Bethlehem Steel Company, Bethlehem, Pa.



BETHLEHEM STEEL

Mayari R *makes it lighter... stronger... longer lasting*

Machining Bronze Countershafts

(*Continued from page* 24)

the routing for the other sections and the second assembly are quite the same, save for differences in detail.

COUNTERWEIGHT REAR—REAR HALF

Operation and Equipment

Inspect forgings—bench.
Mill plain side, mill joint face, mill channel and relief, mill top step—Kearney & Trecker vertical miller.
Mill ends, mill top—Cincinnati horizontal miller.
Drill, core drill and bore 2 holes, drill, ream, counterbore and chamfer 2 holes—Baush drill.
Form 4 tapered slots—Allen drill.
Rough and finish turn angle and 8.550 radius—Foster Fastermatic.
Finish mill plain face, finish mill joint face—Kearney & Trecker vertical miller.
Lap joint face—Gardner lapping machine.
Finish mill channel and relief to depth—Kearney & Trecker vertical miller.
Burr and stamp—Bench; Wash — Spray booth; Inspect—Bench.

COUNTERWEIGHT ASSEMBLY—FRONT

Line bore 2 bolt holes—Heald Bore-Matic.
Finish mill channel to width—Kearney & Trecker vertical miller.
Cut 2 keyways to each half—Cincinnati horizontal miller.
Inspect holes—Bench.
Assemble details—Bench.
Line bore 4 counterweight holes—Heald Bore-Matic.
Finish turn 8.500 radius—Foster Fastermatic.
Straddle mill ends, finish mill top face—Cincinnati duplex miller.
Finish mill step—Kearney & Trecker vertical miller.
Finish line bore 4 counterweight holes—Heald Bore-Matic.
Varsol wash—Spray booth.
Disassemble—Bench.
Finish mill 4 keyways—Gorton Profiler.
Drill, ream & sink 2 pin holes in each half—Allen drill press.
Break sharp edges, inspect keyways & pin holes, assemble details stamp and polish both ends—Bench.
Polish all over—Polishing jack; Varsol wash—Spray booth; Inspect final—Bench.

Referring to these routings, it may be noted that most of the initial machining operations are performed in Kearney & Trecker vertical milling machines and Cincinnati horizontal mills, and Foster Fastermatic turret lathes. The Foster lathe is provided with multiple tooling for turning the OD and facing simultaneously, using cemented-carbide tools. Owing to the use of positive clamping and work-holding devices, there is quite a problem of holding the work true and free from warpage.

The routing for the assembly indicates the operations required to produce a mating assembly after the two halves have been finish-machined. It will be noted that the bolt holes and counterweight holes are precision-bored in Heald Bore-Matics, the four counterweight bores being finished in two separate settings. The alignment of the work is so critical on these operations that it was necessary to develop special work-holding devices to prevent warpage due to excessive pressure. In their final form these clamping devices are cam-locked by hand against a calibrated spring pressure.

Each half has two keyways which have to be held to precise limits as to dimensional tolerances and alignment. These are cut in a Cincinnati mill, then following assembly machining the halves are dis-assembled and the keyways finish-milled in Gorton profiling machines. Although these machines are designed for automatic cycles of profiling, at Tocco the tool is guided by hand with the operator moving a long lever with light pressure. It is estimated that a change in pressure during this cycle could easily affect the size of the delicate profiling cut and ruin the work.

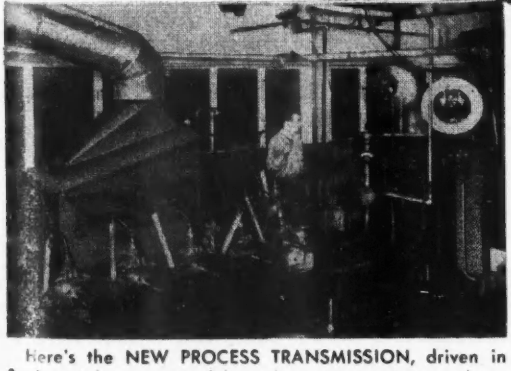
Each of the four keyways contains a small pin hole which must be drilled, reamed, and countersunk in precise location with respect to the keyway. This specification is so critical as to require a separate handling for each hole. Consequently, the work is done in individual steps on sensitive Allen drills and requires four different fixtures and four different machine handlings.

The pictorial section contains illustrations selected from various stages in the machine shop with particular emphasis upon the newly installed counterweight line.

Excellence of Design
Hoover, the Aristocrat of Bearings, are of the Super-Conrad Deep Groove Type employing the largest size and greatest number of balls. This type of bearing, plus the added advantage of Hoover's exclusive honed raceways has been proved, by actual test, to be the most universally dependable for the varying conditions of load and speed under which modern machines operate.
HOOVER
BALL AND BEARING COMPANY, ANN ARBOR, MICHIGAN

THERE'S MORE THAN GEARS IN

New Process TRANSMISSIONS



Here's the NEW PROCESS TRANSMISSION, driven in final test by a powerful truck motor against a dynamometer, simulating all operative loads. This stout transmission, just off the production line, has been qualified by constant laboratory-control of metal specifications, micrometric inspection of tolerances, or instrument recordings of operation at each stage of manufacture. Smooth, quiet efficient, easy-shifting . . . built to endure in service beyond the life expectancy of any truck chassis in which it is mounted.

All the science, skill and manufacturing experience gained through more than 60 years of gear making is advanced in the design of New Process transmissions. Their war service in all climates, under all conditions, presents an unchallenged record of transmission performance. Throughout the war period, over 500,000 transmissions have been furnished for various types of military vehicles.

New Process 1½-Ton Truck Transmission

Four forward speeds and reverse, equipped for double power take-off . . . anti-friction bearings, integral clusters. Ratio designed for quick speed pick-up for ambulances, chemical fire-trucks, combat vehicles, etc. Write for engineering specifications.

New Process GEAR CORPORATION

TRANSFER CASES • TRANSMISSIONS • CONSTANT VELOCITY UNIVERSAL JOINTS • AVIATION GEARS • DIFFERENTIALS

Syracuse, N. Y.

DESIGN COUNTS

COMPARE a modern sewing machine with the old-time model shown here. The difference is an example of how careful attention to design brings about a high level of efficiency.

Realizing this, design is one of the most carefully considered factors in the production of antennas at THE WARD PRODUCTS CORPORATION. It is only through superior design that the benefits of experience and the finest production facilities can be best brought to the user.

For the finest antennas for all applications . . . for home and automobile use . . . look to WARD.

WARD Antennas

BUY WAR BONDS

THE WARD PRODUCTS CORPORATION
1523 EAST 45TH STREET • CLEVELAND 3, OHIO

Export Dept. C. O. BRANDES, Mgr. 4900 Euclid Avenue Cleveland 3, Ohio

Canadian Office ATLAS RADIO CORP 560 King Street W. Toronto 1, Ont., Can

MODERN Production Welding is done on C-F Positioners—without crane assistance, without sling crews, without extra floor space for "flopping" the weldment around so that all sides can be welded "down hand." On a C-F Positioner, the welder himself tilts and turns the weldment to position with a push button control—can tilt it up to 135° beyond horizontal, turn it to any angle or rotate it at any speed from 0 r.p.m. up.

C-F Positioners come in capacities for all weldments—from small hand operated positioners to giant units that easily handle great weldments weighing up to 30,000 lbs. (1 No. 140, C-F Positioner, Capacity 14,000 lbs. and 2 No. 60, 6000 lbs. capacity illustrated).

Write for Catalog

C-F POSITIONERS

CULLEN-FRIESTEDT CO.
1322 S. Kilbourn Avenue, Chicago 23, Ill.

Control System of Constellation

(*Continued from page* 33)

1. The cockpit control must always be connected directly to the control surface. A hydraulic connection was found to be extremely undesirable.

2. The stick force should always be given percentage of the total control surface hinge moment at a given surface angle.

3. The booster system must not "motor." With improper design. it is possible for any type of mechanical servo unit to act in reverse and drive the load. A test jig set-up was practically wrecked in motoring tests. The basic theory has been worked out, and it is now possible to compute closely the booster frequency and actually make the booster a flutter dampener. This required the time of a highly competent mathematician for more than a year.

4. It must be possible to fly the airplane with no power.

5. The rate of application of control surface angle must be evaluated for each type of airplane and adequate rate of booster response provided. This rate is about 40 deg. per sec. on the Constellation. This rate must be provided under adverse and emergency conditions.

6. Dual sources of power should be available automatically.

7. Relief valves should be used to limit the maximum control surface loads to their design values.

8. There must be no "dead spots," particularly through the neutral control point.

9. The trim tab effectiveness must not be lost due to booster friction.

10. Rapid shut-off means should be provided.

11. Until the basic elements are well proved in service, dual units or other auxiliary means must be provided for elevator and rudder control.

12. The unit must be capable of operating at very low temperature.

Complying with these conditions, the Constellation control system has proved to be a reliable and highly satisfactory method of obtaining the advantages previously outlined in this paper. Any one engine, operating at idling speed or above, can supply power to operate all boosters in any conceivable maneuver. Auxiliary elements are provided for the elevator and rudders. The elevator control, in addition, can be shifted in ratio, and with both hydraulic boosters off one pilot can make a landing at about 100 mph using manual only. Many such special precautions have, of course, been taken to insure absolute safety in order to answer all criticisms

(*Turn to page* 98, *please*)

How to get your money's worth in used machine tools

UNQUESTIONABLY, there are many real bargains on the Government Machine Tool Surplus Lists. And you can be sure of getting them if you remember that there are three variables involved: price, accuracy and life.

A machine tool, at its original price, offers a specific degree of accuracy over a definite life expectancy.

The question, then, on any used machine tool, comes down to this: "Can I get the accuracy my product requires long enough to justify my investment?"

CONSULT THE MANUFACTURER

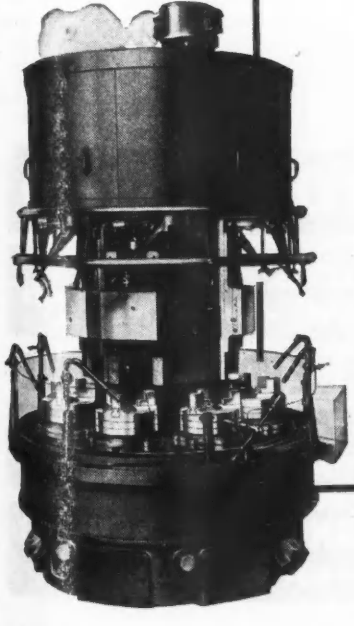
Where can you get the answer? The manufacturer of that machine is your best source. Knowing the history of that machine, he will determine how much it will cost, above your purchase price, to put it to work in your shop. He will tell you how long you can expect to get the accuracy you want.

If that machine tool has outlived its usefulness to the extent that it will not give you the accuracy you want over a profitable period, you can depend on the manufacturer to advise against purchase. For, remember, even on a used machine tool, his reputation is still at stake. Your dissatisfaction over a bad investment would hurt him even more than you.

CONSULT BULLARD

Specifically, on used Bullard Machine Tools, write to us for information by machine number, outlining your intended use.

The Bullard Company, Bridgeport 2, Connecticut.



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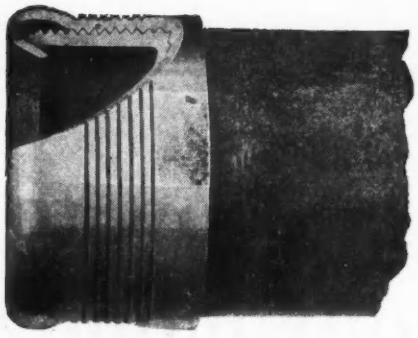

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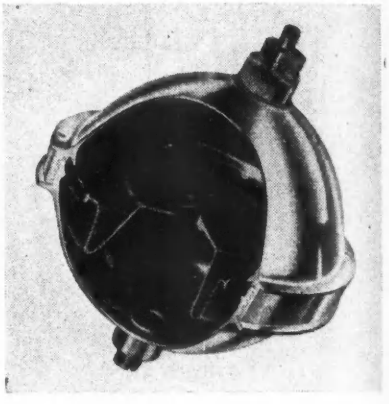
on this unorthodox control arrangement.

To prove the design principles described and to develop all phases of the hydraulic system, the hydraulic boosters, landing gear, flaps, pumps, complete plumbing arrangement, automatic pilot, brakes, and cockpit were built up in the laboratory to full scale. The exact space relationship between all components was reproduced. Four Ford motors, controlled from the cockpit to simulate the airplane engines, drove the hydraulic pumps. The air loads on the flaps and gear were simulated. Large springs were used to develop the actual air load existing on the elevators, rudders, and ailerons. These loads were derived from wind tunnel



Hydraulic accumulator, of which there are three five-in. units, two for the brake system and one for the auxiliary booster system. Each unit contains a synthetic rubber diaphragm to separate the fluid and air, the precharge air pressure being 600 psi.

tests. Arrangements were made to reproduce the loads occurring at 80, 120, 200, and 350 mph to cover the full speed range of the Constellation.

This elaborate mockup was then used to study proper boost ratios, friction, effect of loss of engine power, interaction of all hydraulic components, and to do basic development work on the pumps, valves, and all other compo-

(*Turn to page* 102, *please*)

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REMEMBER?

When steel cartridge cases were considered impossible, until the whole industry joined to lick the tough job of cold-flowing metal, with the aid of improved drawing lubricants? ● Those same compounds are now being applied to the difficult draws of fenders, refrigerators, headlights and many consumer products.

REMEMBER?

When liquid carburizing was thought to be limited to .040" depths? But light armor plate and pilot shields during the war utilized salt bath carburization, with cases up to .120". ● Houghton's "*Perliton*," a pioneer ten years ago, offers case-hardening advantages with which every metal plant should be familiar as plans are made to reconvert.

REMEMBER?

When some said the black oxide finish would be only a war-time substitute for plating? ● But controlled oxidation of steels is here to stay, and will be widely used in post-war. *Houghto-Black*, uniform, controllable and economical—warrants careful investigation for future product finishing.

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You who called on Houghton when the going was tough in early war days can continue to rely on this organization to help cushion the shock of reconversion. Feel free to call the nearest Houghton office, or write direct to E. F. HOUGHTON & CO., 303 W. Lehigh Ave., Philadelphia 33, Pa. Plants also in Chicago, Detroit, San Francisco and Toronto.

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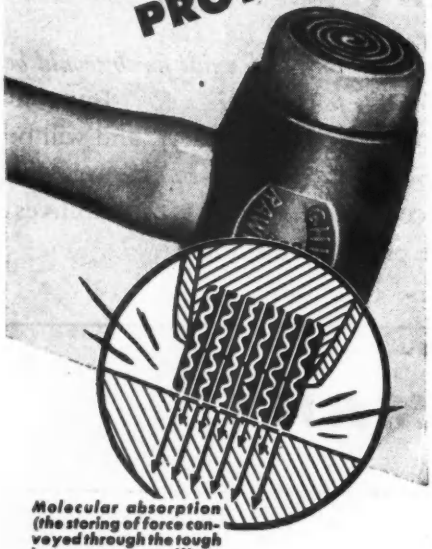

Molecular absorption (the storing of force conveyed through the tough interwoven, resilient hide fibres) converts velocity into effective thrust.

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nents. The work went on for more than three years. To study the effect of low temperatures on the booster system, the whole tail assembly was enclosed and its temperature lowered to —70 F. After freezing, the controls were operated and forces measured. Contamination tests involving the deliberate addition of dirt and water to the hydraulic fluid have also been run at normal and low temperatures. Cable tension regulators to compensate for the change in fuselage length with internal pressure and temperature were developed to maintain uniform control feel under all conditions.

The laboratory tests did not answer all problems on the control boosters, primarily because the desirable control forces were not known until after the airplane flew. A secondary factor was the effect of friction on trim which was not simulated on the mockup. On the whole, the laboratory tests were about 95 per cent effective in covering flight conditions. One of the outstanding advantages of the control mockup was that it provided the opportunity to abuse deliberately the various systems under safe conditions and thereby showed up potential weaknesses which probably would not have been uncovered otherwise. Both the engineers and flight test pilots soon provided a member of their groups who acted as the official "wreckers" during tests. A secondary but important advantage of the mockup was provided in that the pilot personnel could contribute their criticisms and comments during the design stages and also be shown all features of the design. This went far to get their enthusiastic support on the over-all problem.

The basic information developed on this type of control has been used to provide similar controls on several high production Lockheed airplanes with good success. It is felt that the principles have been well established and that the mechanical booster is the forthcoming type of control, not only for large aircraft but also for the small, fast, high-speed types.

Because of the novelty of its conception much of this article has been devoted to the control surface booster system. The remainder of the controls of the Constellation show the same ingenious and painstaking treatment and some description of them is in order.

The front wheels of the tricycle landing gear of the Constellation are controlled hydraulically both to retract them in flight and to turn them on the ground for steering. Both of these mechanisms have double acting pistons. The directional control cylinder is mounted to the shock strut cylinder and the piston rod is connected through torque arms to the shock strut piston.

The wing flaps are of the type which first move back to increase wing area and then slant down through an arc of approximately 45 deg. In order to accomplish this there is a mechanism driven by hydraulic motors with gear

(*Turn to page* 105, *please*)

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reductions and then through an intermediate reducing gear to a chain and cable drive. In case of hydraulic failure an additional mechanical hand drive is provided operated by an emergency hand crank.

The automatic pilot is also hydraulically operated by push-pull servo units attached to the airplane structure, the piston rod being attached to the flight station torque tubes. One unit is used for the ailerons, one for the elevator and one for the rudder. Each unit contains a hydraulically-operated by-pass and two pressure relief valves, which open when the unit is over-powered manually.

The aileron, elevator and rudder tabs are manually operated through cranks and reduction gear unit.

The cabin air fan is driven by a hydraulic motor with fluid supplied by the secondary pumps. A cable controlled shut-off valve is used to start and stop the fan and an adjustable restrictor controls its speed.

The propeller governors are electrically-controlled as are the cowl flaps, both upper and lower, and the oil cooler flaps. Electrical controls are also employed for the fuel dilution system, the fuel ut-off valves. the carburetor air rcuit as well as most of the in- instruments.

e numerous solenoid valves, valves, etc. are employed in the hydraulic circuits they have n enumerated as to do so would equired explanations far out of pe of this article. Hydraulic actors are used wherever it is deto have hydraulic energy storher to prevent severe drops in e during the operation of hydevices or to provide for the on of these devices over a numcycles with the main engines tive.

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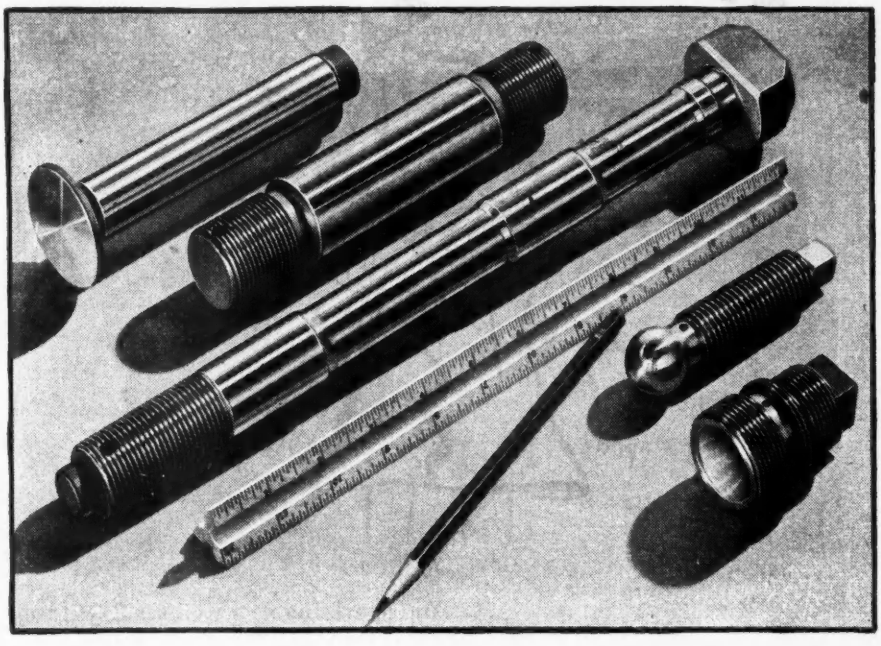

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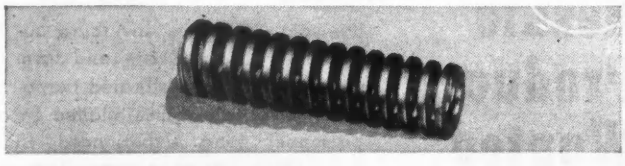
Wage Incentives

(*Continued from page* 15)

Over a period of many years they have been tested wisely and have worked well. They have also been tried unwisely and have failed. But belief in their efficacy under intelligent handling is undoubtedly spreading. Certain authorities hold that some of the methods and systems that have been successful on war work will not do as well in peace-time production, but that possibility can only call for necessary or desirable adjustments.

Organized labor has rather generally opposed wage incentives in the past. It has also favored curtailed production. But, in both respects, there is a spreading change of attitude. A nationally known labor lawyer has talked recently about the folly of demanding more pay for less productive work. In the book "Organized Labor and Production" the collaborating authors, Philip Murray and Morris L. Cooke, whether or not their words jibe with their actions, said, "In recent years trade union leaders have realized that wages come out of the total production of the plant and the way to get higher wages is to produce more goods." Another leader active in the labor union field has lately asserted that the standard of living rests on productivity and, to get maximum productivity, wage incentives are necessary.

All of this differs fundamentally from the presently and politically advocated method of boosting the minimum and raising the upper classifications to correspond relatively without regard to compensating output. In cold calculation, work is worth what it produces. To get more for his work, one should produce more in quantity, value or both. Intelligently applied incentives have shown that they inspire effort in that direction and, under the American system, it is the desire for personal gain and self-betterment that turns the wheels of our productive machinery.



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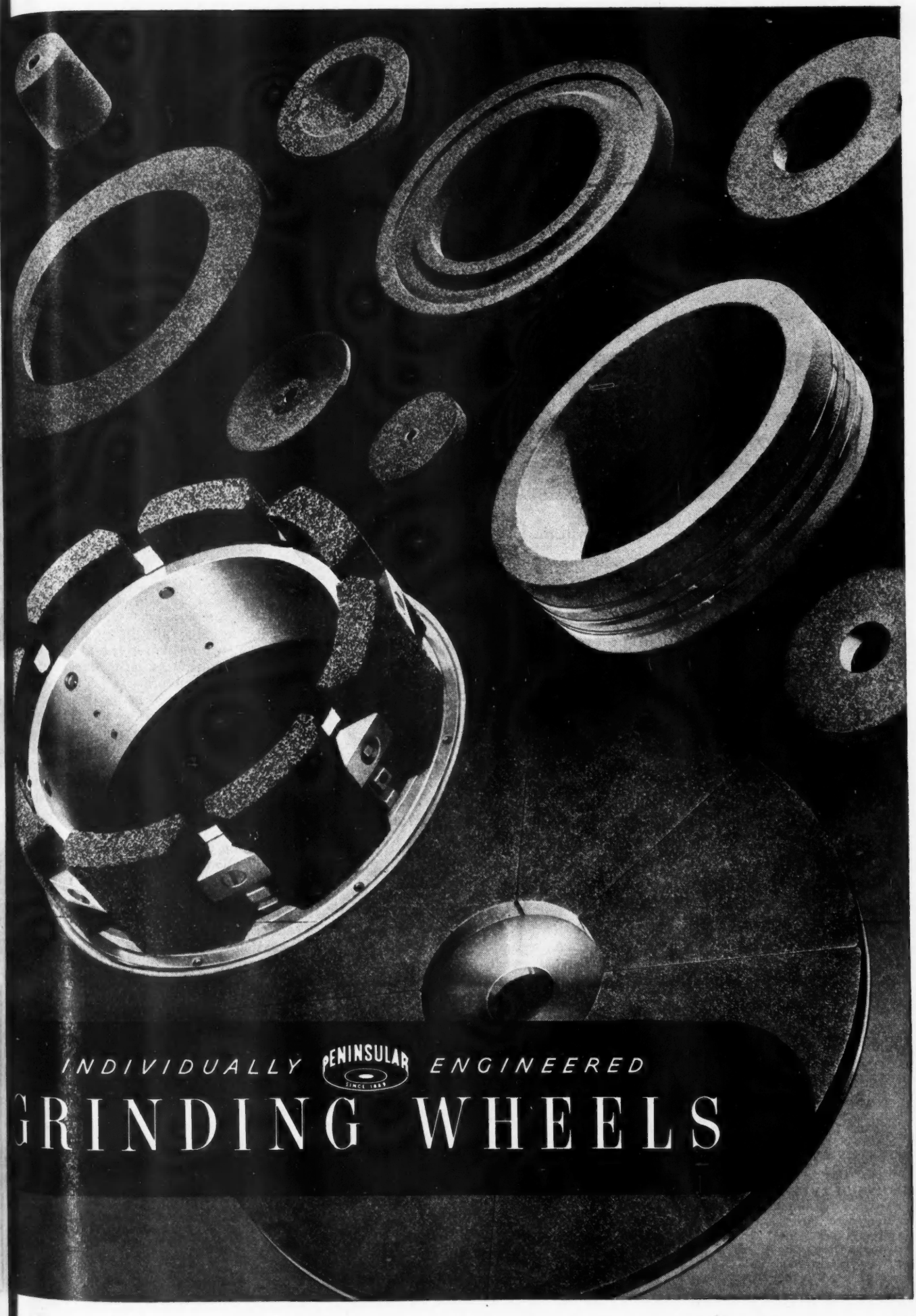
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Primary Balancing of Radial Engines

(*Continued from page* 40)

tional term, a function of link-rod rotating weight and master-rod geometry.

In addition to these methods of determining counterbalance requirements of radial engines, there is a graphical method which has had considerable use in design of reciprocating machinery and which has been used extensively by at least one radial engine manufacturer. This method (Diagram page 40), like the Coppens method, results in an answer somewhat higher than that given by the conventional method.

The discrepancy among the results obtained by the foregoing methods can be explained by careful analysis of the procedures used. As outlined above, the weight of the link rod may be divided into rotating and reciprocating portions by weighing. In the usual method, this rotating portion is multiplied by n-1 (where n is the number of cylinders in the row) and the product treated as pure rotating weight. This is clearly an incorrect procedure since the center of gravity of these combined n-1 portions of link rod weight will not be at the center of the crankpin because of the absence of a link rod at the master rod cylinder position. This center of gravity actually falls on the master rod axis at a point below the center line of the big end; that is, in a direction opposite the piston pin. It is, therefore, not pure rotating but partly reciprocating (or negative sign). This division into true rotating and reciprocating weights can be accomplished mathematically but it is easier to assume a fictitious weight at the master rod position which will bring the center of gravity, in question, to the crankpin center. This imaginary weight must lie on the master rod axis and its moment about the crankpin center must be equal to the product of the rotating weight of one link rod (as determined in the conventional manner) times the radius of the knuckle pin circle. This operation will complete the symmetry of the moments of the link-rod rotating

(*Turn to page* 112, *please*)

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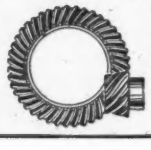

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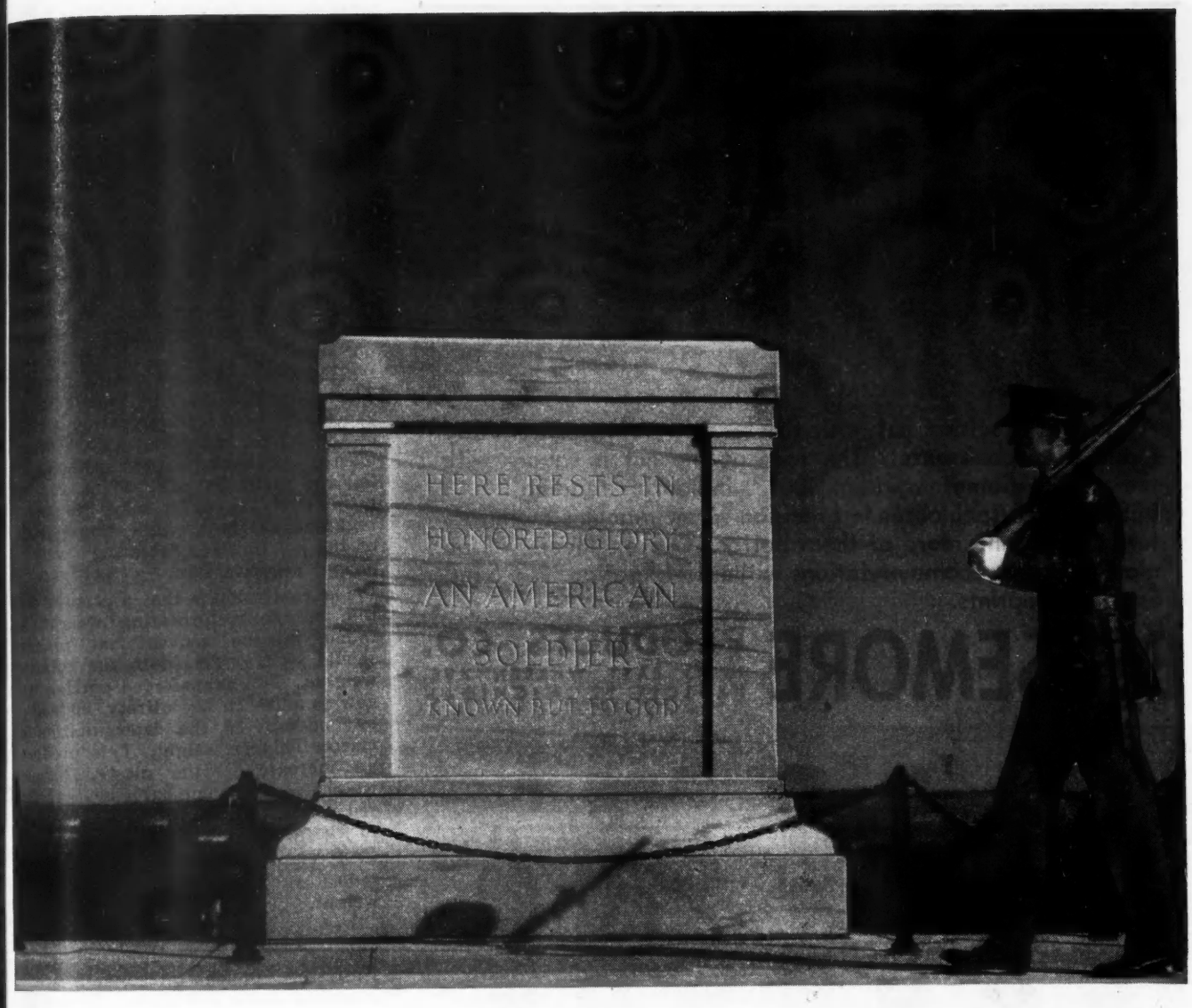

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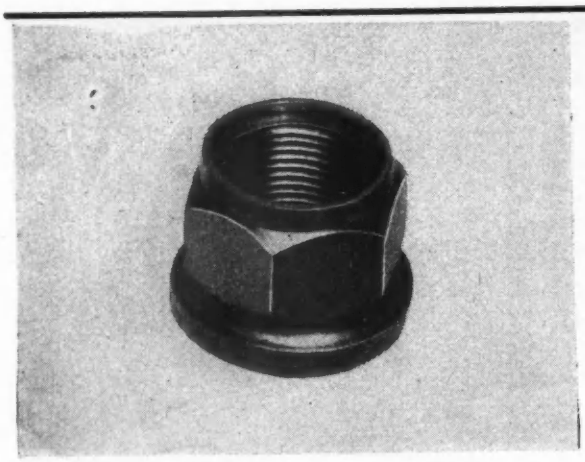

This is one of the group of samples of precision parts (illustrated below) of ferrous and non-ferrous alloys that have been made by Bessemore. On each of them, the screw machine work was completed within ten and twenty-five seconds and .002" tolerances were maintained. The grinding work is held to .0001" (tenth).

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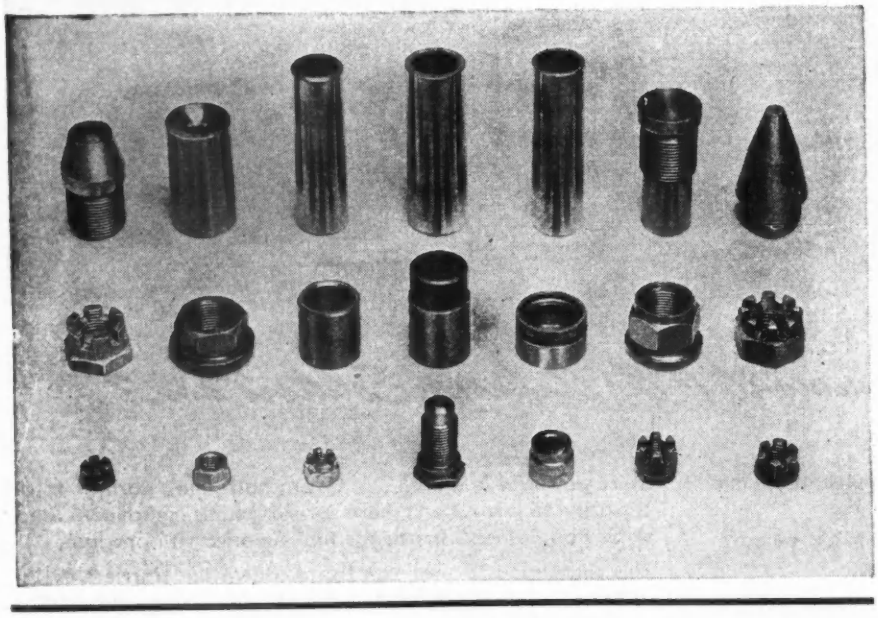

weights, and the center of gravity may correctly be assumed at the crankpin center. While this imaginary weight might be assumed to lie on the intersection of the knuckle-pin circle and the master rod axis, it is more convenient and exactly equivalent (insofar as the moment is concerned) to assume the weight to be acting at the piston pin of the master rod and reduced in size by the ratio of the radius of the knuckle pin circle to the master rod length. This weight must be added in as part of the rotating weights since it completes the symmetry of the link rod rotating weights. In order that it not be counted twice, it must be subtracted from the reciprocating weights. This subtraction may be thought of as a decrease in the reciprocating weight of the master rod because part of the master rod shank goes toward completing the symmetry of the link rod rotating weights, or it may be simply regarded as the reciprocating portion of the *n-1* link rod "rotating" weights and of negative sign.

The conclusion is that a certain portion of the reciprocating weight, as found in the conventional manner should be transferred to the rotating weights. This transferred portion will now be added in its entirety, instead of by one-half, in the determination of master balance weight. This produces an increase in the master balance weight equal to one-half the transferred portion. This increase is identical to the term, mentioned earlier, that Professor Coppens adds to what has been the conventional master balance weight.

By an entirely different approach we have arrived at the same results as Professor Coppens. This approach is mathematically less elegant but probably more acceptable to the average engineer who has hesitated to admit a result which apparently contradicts the generally accepted theory. Actually, no real contradiction exists. Professor Coppens has simply uncovered an error in the usual method of division between reciprocating and rotating weights. It is unfortunate that he failed to make this clear in his papers. The impres-

(*Turn to page* 114, *please*)

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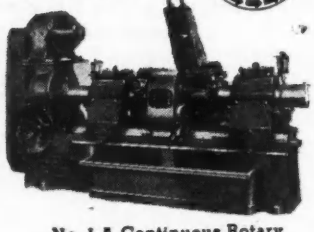

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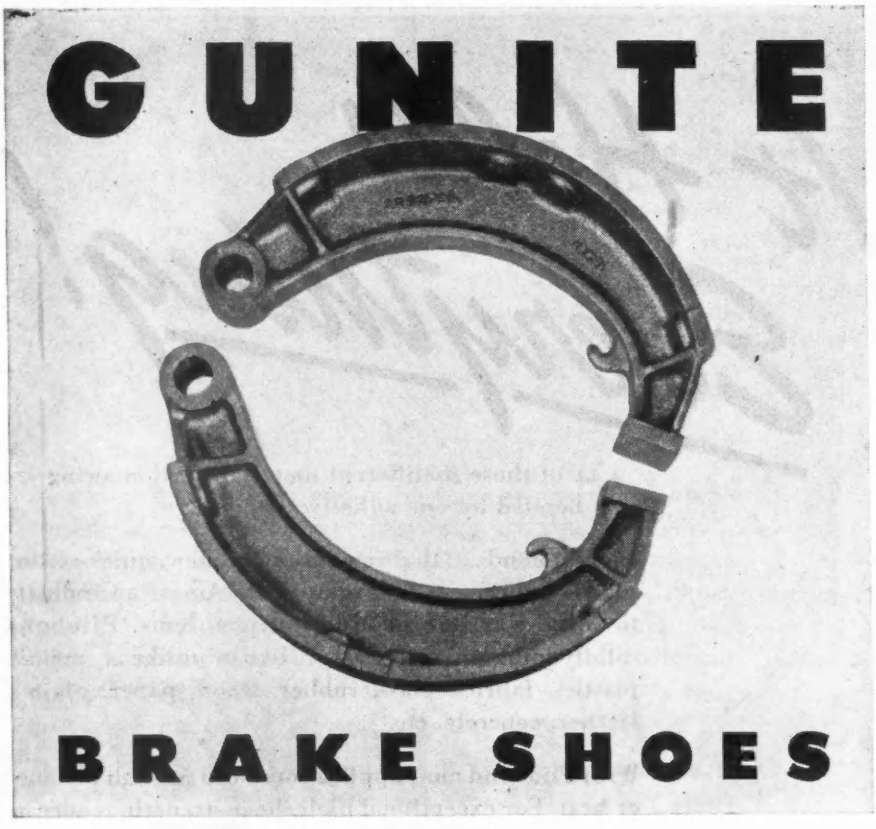

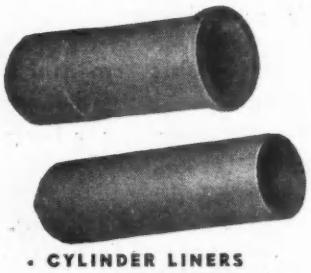

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sion is conveyed in his work that the principle of balancing to *half* the reciprocating and *all* the rotating is wrong; whereas, as shown above, this is not the real significance of his results at all.

As shown by Professor Coppens, the actual numerical differences involved in the comparison of balancing methods are relatively small, being in the neighborhood of 0.3 per cent. However, this approaches the magnitude of the tolerance generally considered allowable in the balancing of radial engines.

A system of weighing which would give the correct results directly is possible. If the connecting rods could be weighed as a complete assembly, that is, with the link rods in place on the master rod, the errors ordinarily occurring would be eliminated. Such treatment of the complete rod assembly may be possible in a five-cylinder row but scarcely seems practical for seven or more cylinders. Another scheme which could be used is to weigh the link rods in the conventional manner and to make special weights equal to the rotating portions in the form of sleeves which will fit over the knuckle pins in the master rod big end. With these sleeves representing the rotating portions of the link rods in place, the master rod is weighed in the conventional manner. The reaction at the big end will represent the *total* rotating weight. The measured reciprocating weight of the master rod will be somewhat reduced by the presence of the sleeves and the correct division between reciprocating and rotating portions will be obtained.

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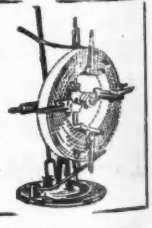

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(*Continued from page* 25)

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(*Turn to page* 120, *please*)

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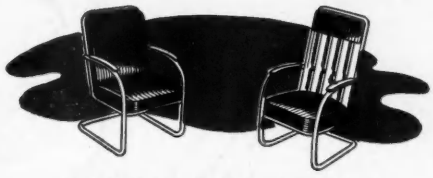

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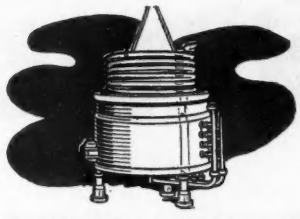

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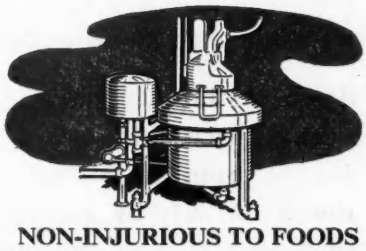

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